



Total Maximum Daily Load

for

Cuivre River and North Fork Cuivre River Pike and St. Charles Counties

Section 303(d) Listing: *Escherichia coli* Bacteria

Submitted: August 2, 2023

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Approved: February 8, 2024

WATER BODY SUMMARY

Total Maximum Daily Loads (TMDL) for Cuivre River and North Fork Cuivre River 303(d) Listing: *Escherichia coli* (*E. coli*) Bacteria

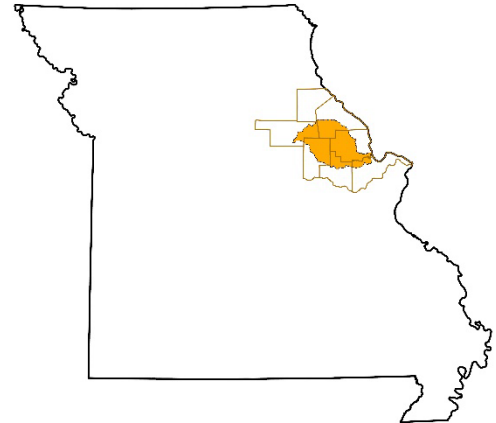
Water body	TMDL Development Priority
Cuivre River	Low
North Fork Cuivre River	High

Location: Pike and St. Charles Counties

8-digit Hydrologic Unit Code (HUC):¹
07110008– Cuivre River

12-digit HUC Subwatersheds
See Section 2

Water Body Identifications (WBIDs) and Hydrologic Class:²
WBID 152 – Class P – Cuivre River
WBID 158 – Class P – North Fork Cuivre River



Location of watershed in Missouri

Designated Uses:³
Irrigation
Livestock and wildlife protection
Human health protection
Warm water habitat (aquatic life)
Whole body contact recreation category A
Secondary contact recreation

Impaired Use:
Whole body contact recreation category A

Pollutant Identified on the 2022 303(d) List:
Escherichia coli (*E. coli*) (fecal indicator bacteria)

Identified Sources on the 2022 303(d) List:
Rural nonpoint sources

Length and Location of Impaired Segments:
Cuivre River (WBID 152): 30 miles, from Sur 1795, Township 48N, Range 2E to Section 14, Township 49N, Range 1W
North Fork Cuivre River (WBID 158): 25.1 miles, from mouth to Section 24, Township 51N, Range 3W

¹ Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2019). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

² For hydrologic classes see 10 CSR 20-7.031(1)(E). Class P streams maintain permanent flow even in drought periods.

³ For designated uses see 10 CSR 20-7.031(1)(F) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

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1. Introduction

In accordance with Section 303(d) of the federal Clean Water Act, the Missouri Department of Natural Resources is establishing total maximum daily loads (TMDLs) to address elevated concentrations of *Escherichia coli* (*E. coli*) bacteria in the Cuivre River located in Lincoln and St. Charles counties, and North Fork Cuivre River in Pike and Lincoln counties. This TMDL report addresses two water quality limited segments that are on Missouri's 2022 303(d) List of Impaired Waters due to exceedances of Missouri's *E. coli* bacteria criterion.⁴ These listings were approved by the U.S. Environmental Protection Agency (EPA) on August 2, 2023.⁵

Section 303(d) of the federal Clean Water Act and Title 40 of the Code of Federal Regulations (CFR) Part 130 require states to develop TMDLs for waters that do not meet applicable water quality standards. Missouri's Water Quality Standards at Title 10 of the Code of State Regulations (CSR) Division 20 Chapter 7, Rule 7.031 consist of three major components: designated uses, water quality criteria to protect those uses, and an antidegradation policy. A TMDL is equal to the loading capacity of a water body for a specific pollutant and represents the maximum amount of a pollutant that a water body can assimilate and still attain and maintain water quality standards. The *E. coli* bacteria loading capacities for each water body are derived from the maximum *E. coli* concentration allowed by Missouri's Water Quality Standards and are translated to mass loads using stream flow under all recorded conditions. Once the loading capacity of a water body has been quantified, existing and future point sources and nonpoint sources are assessed for their potential to contribute the pollutants of concern. In accordance with 40 CFR 130.2, contributing point sources are assigned a portion of the available loading capacity as a wasteload allocation and nonpoint sources are assigned a load allocation. In accordance with federal Clean Water Act section 303(d)(1)(C), a margin of safety is also included. Margins of safety can be explicit (numeric) or implicit (qualitative) to account for any lack of knowledge concerning the relationship between pollutant loading and water quality, uncertainty associated with the model assumptions, or data inadequacies (40 CFR 130.7). The TMDL for each pollutant is the sum of the wasteload allocation, the load allocation, and the margin of safety.

2. Watershed Description

Cuivre River and North Fork Cuivre River are located north of St. Louis within the Cuivre River subbasin, which is cataloged by the U.S. Geological Survey (USGS) as the 8-digit hydrologic unit code (HUC) 07110008. The Cuivre River subbasin is composed of 34 individual 12-digit HUC subwatersheds totaling 1,261 square miles. These subwatersheds are listed and depicted in Appendix A. The North Fork Cuivre River (WBID 158) originates at the eastern border of Lincoln County and flows south for 25 miles where it merges with the West Fork Cuivre River and becomes the Cuivre River (WBID 152). The Cuivre River flows southeast for 42 miles and flows into the Mississippi River. The impaired segment of the Cuivre River is the northwest, 30 mile-upstream segment of the river. The size of the watershed draining to the impaired segment is 1,231 square miles (Figure 1). Within this watershed is the North Fork Cuivre River watershed which is 337 square miles.

⁴ A water quality limited segment is any segment where it is known that water quality does not meet applicable water quality standards, or is not expected to meet applicable water quality standards, even after the application of the technology-based effluent limitations required by sections 301(b) and 306 of the federal Clean Water Act (40 CFR 130.2).

⁵ The Department maintains current and past 303(d) lists and corresponding assessment worksheets online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/impaired-waters.

Within the Cuivre River subbasin, four water bodies are listed as impaired and one water body has a previously developed TMDL. The four impaired water bodies are the Cuivre River (WBID 152), the North Fork Cuivre River (WBID 158), Vandalia Lake (WBID 7051), and Elkhorn Creek (WBID 189). As previously stated, this TMDL will address the *E. coli* impairments of the Cuivre River and the North Fork Cuivre River. Vandalia Lake's aquatic life use is impaired by Chlorophyll-a and will be addressed in a future TMDL. Elkhorn Creek's aquatic life use is impaired by low dissolved oxygen. In 2006, EPA approved a permit in lieu of a TMDL for Montgomery City NE Wastewater Treatment Plant to address biological oxygen demand, total suspended solids, and ammonia in Elkhorn Creek. The segment above the treatment plant is still listed as impaired and will be addressed in a future TMDL. A TMDL was approved, on July 14, 2008, for Mill Creek (WBID 159) to address sediment. At the time of this document's writing, Mill Creek is attaining water quality standards. The approved Mill Creek TMDL and permit in lieu of a TMDL for Montgomery City are available on the Department's website at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

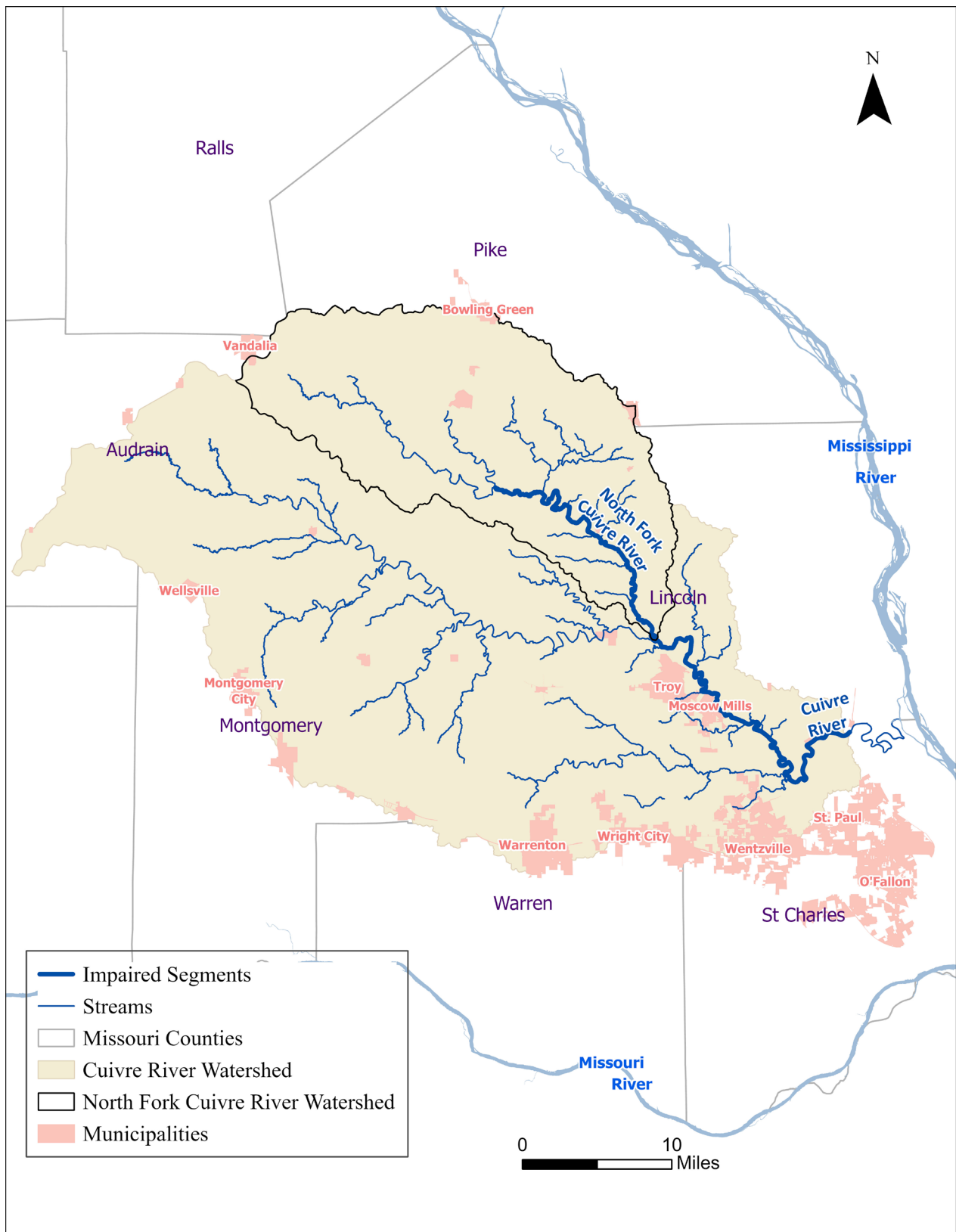


Figure 1. Cuivre River and North Fork Cuivre River Watersheds

2.1 Geology, Physiography, and Soils

The Cuivre River and North Fork Cuivre River are located within the Cuivre/Salt ecological drainage unit (MoRAP 2005). Ecological drainage units are groups of watersheds that have similar biota, geography, and climate characteristics (USGS 2009). Within the Cuivre/Salt ecological drainage unit, approximately half of the Cuivre River watershed is within the River Hills EPA Level IV ecoregion and half within the Claypan Prairie ecoregion. Roughly 70 percent of the North Fork Cuivre River watershed is within the River Hills Ecoregion and the northern 30 percent of the watershed is in the Claypan Prairie ecoregion. Ecoregions are areas with similar ecosystems and environmental resources and are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. By recognizing spatial differences in ecosystems, ecoregions stratify the environment by its probable response to disturbance (Chapman et al. 2002). Ecoregions are defined in Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(H).

The Cuivre River watershed contains temperate prairie to the north and east. The Claypan Prairies contains Putnam-Mexico type soils that retain water and tend to poorly drain. The ecoregion is primarily flat with zero to five percent slopes and the land has largely been converted from prairie grasses to farmland. The rest of the watershed is in the River Hills ecoregion. This ecoregion contains loam and clay soils with some chert. The hills can be quite steep with a slope up to 50 percent (MoRAP 2005).

Soils are categorized into hydrologic soil groups based on similar runoff potentials. Each hydrologic soil group indicates the rate at which water enters the soil profile under conditions of a bare, thoroughly wetted soil surface (NRCS 2009). This infiltration rate determines the quantity of precipitation that flows over land to water bodies as direct runoff. Group A soils have the highest rate of infiltration and the lowest runoff potential. Group D soils have the lowest rate of infiltration and highest runoff potential. Many wet soils fall into dual soil groups (e.g., Group C/D) due to the presence of a seasonal high water table that results in saturation to the soil surface. Dual hydrologic soil groups account for this condition by providing both the drained and undrained condition of the soil.⁶ It should be noted that soil runoff potential is only one factor that determines the volume of runoff in a watershed. Impervious surfaces, vegetative cover, slope, rainfall intensity, and land use can significantly influence the potential for runoff regardless of the characteristics of the underlying soil. Table 1 provides a summary of the hydrologic soil groups by area in square miles and relative percent. Figure 2 shows the distribution of hydrologic soil groups and karst features in the Cuivre River watershed. Geographic Information System (GIS) analysis of the Cuivre River watershed identified 121 springs and multiple losing streams including two segments of the Cuivre River – a 2.1 mile segment and a 1.9 mile segment. Per 10 CSR 20-7.015(1)(B)3, a losing stream is a stream which distributes 30 percent or more of its flow through natural processes, such as through permeable geologic materials, into a bedrock aquifer within 2 miles flow distance downstream of an existing or proposed discharge.

⁶ For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 24 inches (60 centimeters) below the surface in a soil where it would be higher in a natural state (NRCS 2009).

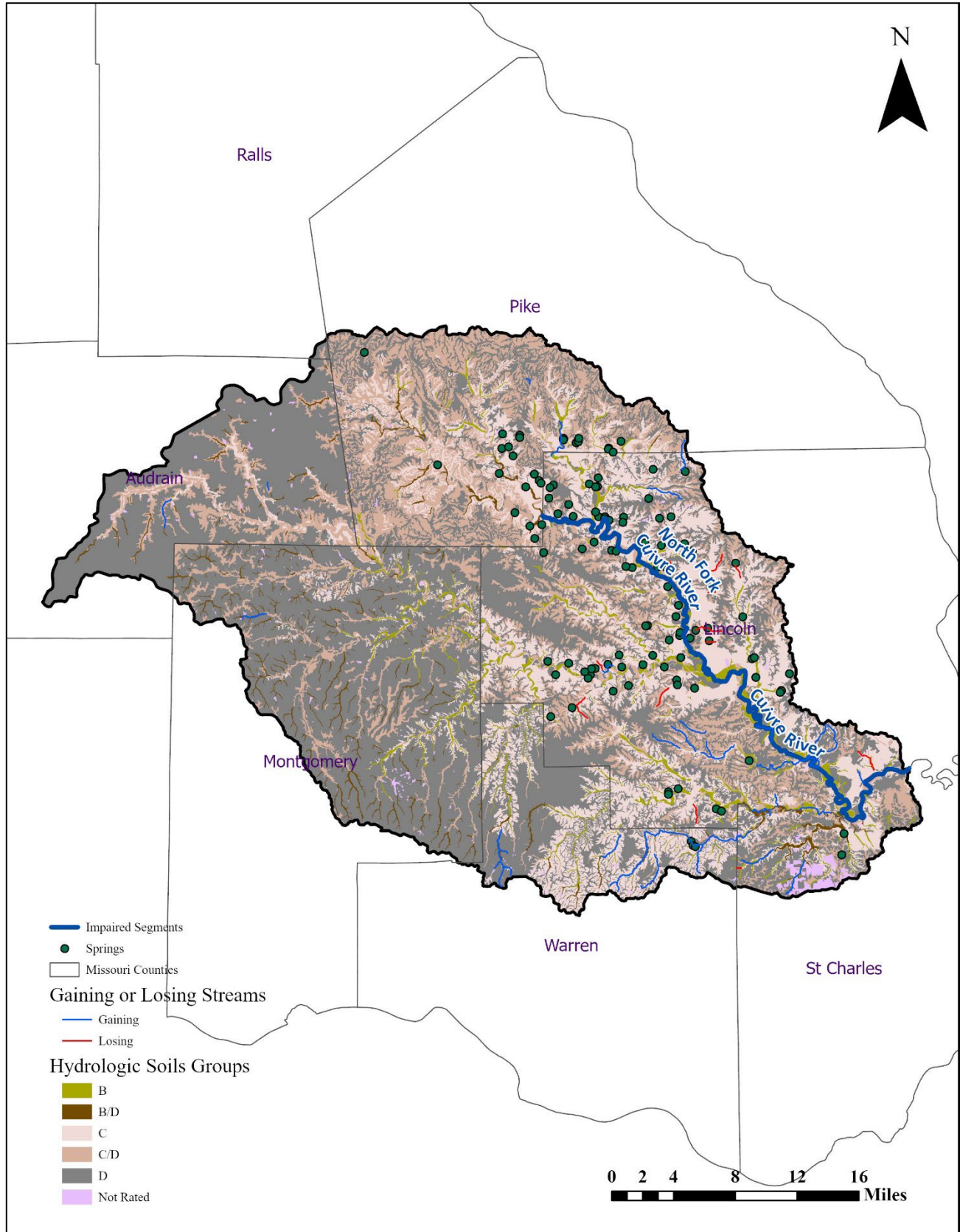


Figure 2. Hydrologic Soil Groups and Karst Features in the Cuivre River Watershed

Table 1. Hydrologic Soil Groups in the Cuivre River and North Fork Cuivre River Watersheds (NRCS 2020)

Hydrologic Soil Group	Area in the Watershed	
	Square Miles	Percent
Cuivre River		
B	44.08	3.58%
B/D	21.15	1.72%
C	261.36	21.21%
C/D	260.32	21.12%
D	633.53	51.41%
Not Rated	11.96	0.97%
Total	1,231.40	100.00%
North Fork Cuivre River		
B	9.45	2.80%
B/D	3.34	0.99%
C	93.82	27.82%
C/D	117.65	34.88%
D	111.74	33.13%
Not Rated	1.28	0.38%
Total	337.28	100.00%

2.2 Climate

The most recent climate data from a weather station in close proximity to the Cuivre River watershed were measured at the St. Peters 2 SE weather station (USC00237475) in St. Charles County. The climate normals were developed based on temperature and precipitation data collected at that station between 1991 and 2020 (NOAA 2022). Precipitation normals are especially important because they relate to stream flow and runoff events that influence pollutant loading. Table 2 presents the 30-year monthly climate normals from the St. Peters weather station for precipitation and temperature. Figures 3 and 4 further summarize these data.

Table 2. 30-year Monthly Climate Normals at St. Peters

Month	Precipitation Total	Minimum Temperature	Maximum Temperature
	in	°F	°F
January	2.44	21.2	39.3
February	2.37	24.8	44.9
March	3.46	33.3	55.5
April	4.74	43.3	67.3
May	4.80	53.5	76.3
June	4.26	63.3	84.4

Month	Precipitation Total	Minimum Temperature	Maximum Temperature
	in	°F	°F
July	4.23	67.5	88.1
August	3.76	65.4	87.2
September	3.07	57.1	80.8
October	3.11	45.2	68.5
November	3.54	35.0	54.9
December	2.56	26.5	43.6
	Total	Average	Average
	42.34	44.7	64.2

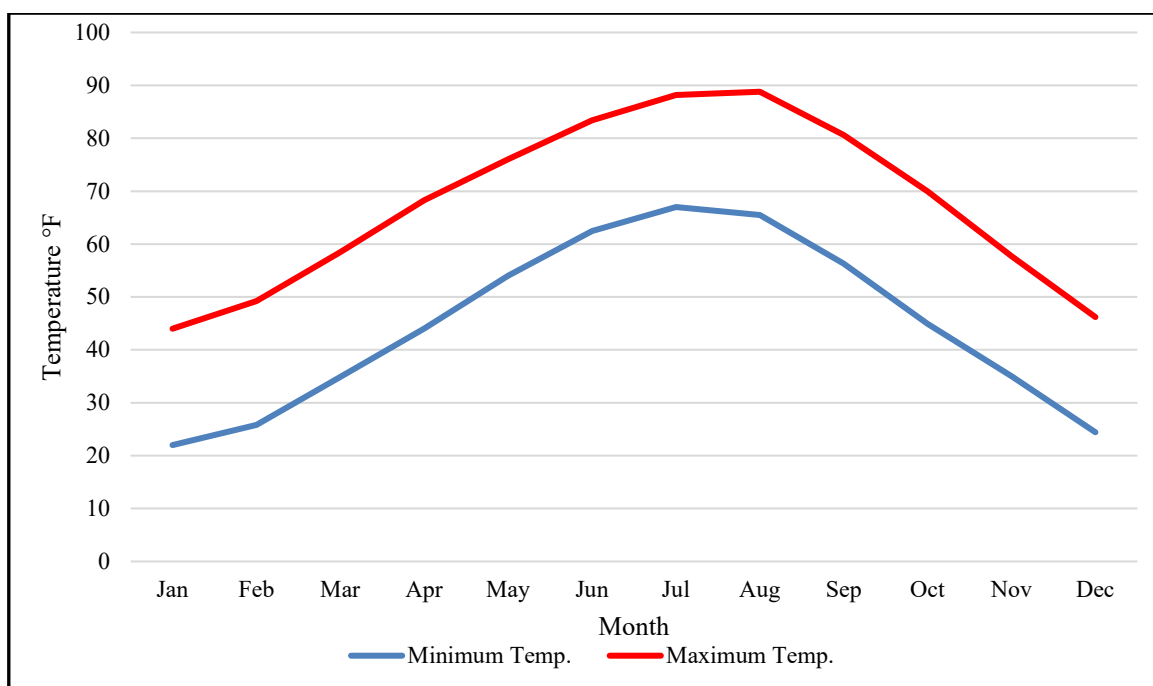


Figure 3. Monthly Minimum and Maximum Temperature Normals – St. Peters

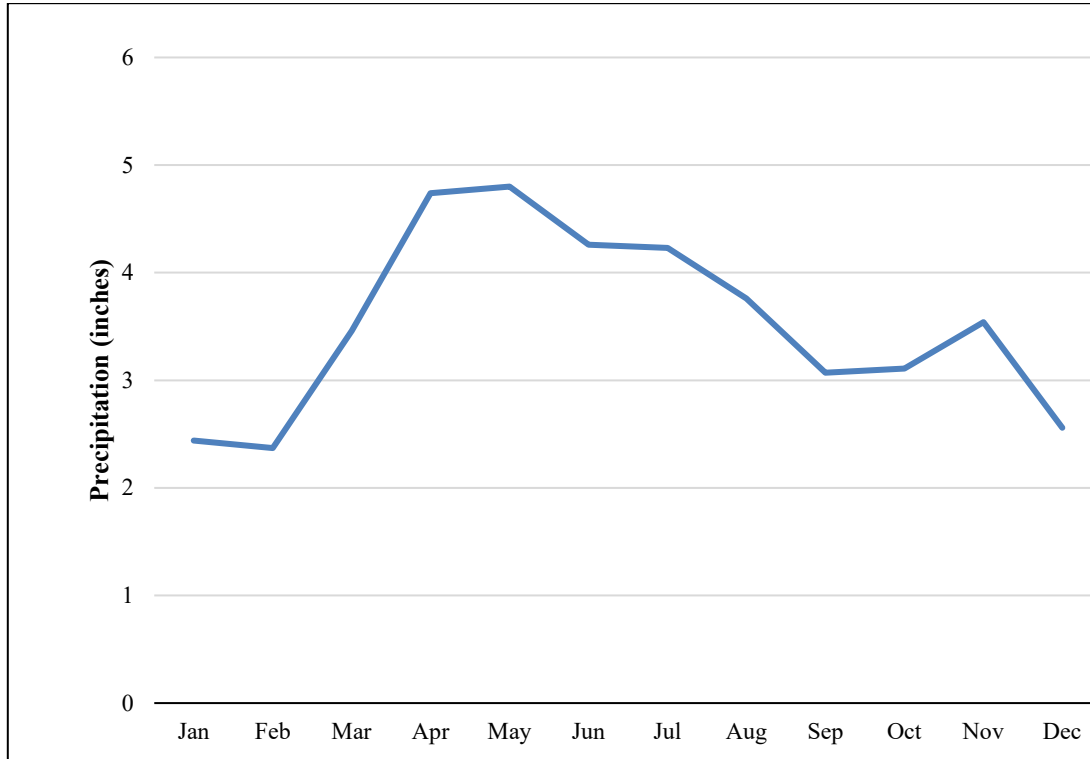


Figure 4. Monthly Precipitation Normals – St. Peters

2.3 Population

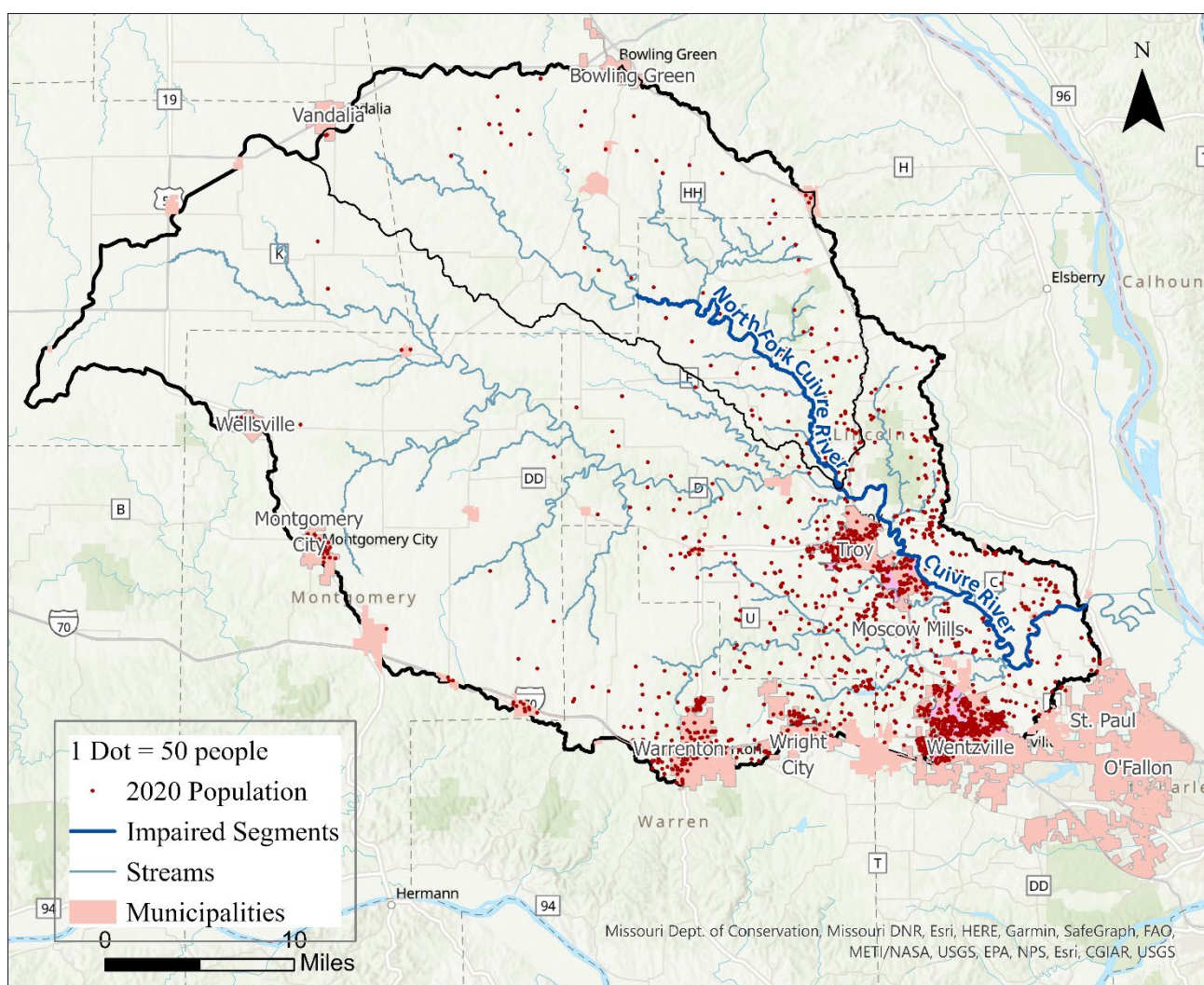
State and county population estimates are available from the U.S. Census Bureau’s 2020 census and can be localized using census block data (U.S. Census Bureau 2020). Population estimates for the Cuivre River and North Fork Cuivre River watersheds were derived using GIS software by overlaying the watershed boundaries over a map of census blocks (Figure 5). Wherever the centroid of a census block fell within a watershed boundary, the entire population of the census block was included in the total. If the centroid of the census block was outside the boundary, the population of the entire block was excluded. The municipal population was estimated using a similar method whereby municipal areas were overlain on the map of census blocks. The rural population was calculated as the difference between the municipal population and the total population.

As shown in Table 3, the populations in the Cuivre River watershed have increased by 83 percent since 2000. Municipalities’ populations grew at a slightly higher rate than rural populations, where the municipalities’ populations more than doubled, while the rural population increased by 55 percent. Population growth can lead to increased impervious surfaces and subsequently higher runoff of *E. coli*. The North Fork Cuivre River watershed also experienced population growth, but at a lower rate than the entire Cuivre River watershed.

At the time of the 2010 census, the U.S. Census Bureau has classified portions of the watershed as being an “urban area.” Urban area designation is one criterion used to determine whether urban stormwater discharges are subject to municipal separate storm sewer system (MS4) permit regulations. Currently, Wentzville, Troy, St. Charles County, and the Missouri Department of Transportation right of ways are subject to such regulations in this watershed.

Table 3. Population data for the Cuivre River and North Fork Cuivre River watersheds

	Census Year	North Fork Cuivre River Watershed	Cuivre River Watershed
Municipal	2000	1,732	26,160
	2010	2,104	45,720
	2020	1,971	56,357
Rural	2000	5,446	30,652
	2010	6,392	40,986
	2020	6,635	47,630
Total	2000	7,178	56,812
	2010	8,496	86,706
	2020	8,606	103,987

**Figure 5. 2020 Population in the Cuivre River and North Fork Cuivre River Watersheds**

U.S. Census Bureau data can also assist with identifying areas in the watershed with potential environmental justice concerns. EPA defines environmental justice as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies (USEPA 2014a). Communities having environmental justice concerns may qualify for financial and strategic assistance for addressing environmental and public health issues. One example of financial assistance the Department offers that may be available to communities having environmental justice concerns is Section 319 grant funding to address nonpoint sources. The Department evaluates 319 grants on a number of criteria, but gives higher priority for selection to proposed projects in disadvantaged communities. Additional grant and financial resource information is available on EPA's environmental justice website at www.epa.gov/environmentaljustice.

Figure 6 shows census block groups' demographic index. This information is one approach that may be used to identify areas where there may be potential environmental justice concerns. The index is computed by the following equation:

$$\text{Demographic index} = \frac{\% \text{ People of Color} + \% \text{ Low Income}}{2}$$

The demographic data used in this analysis is from the U.S. Census Bureau and the index is derived from the Demographic Index used in EPA's web-based EJSCREEN tool. The EJSCREEN tool is available at <https://www.epa.gov/ejscreen>. This index is displayed as the state's percentile to more easily compare areas across the state. Within the watershed, census blocks demographic index range from the first percentile to 82nd percentile. The block with the highest index is just left of Bowling Green and is in the 82nd percentile meaning that its demographic index is 82 percent higher than other census blocks within the state of Missouri. Areas with an index above the 80th percentile may have environmental justice concerns.

Environmental justice encompasses a wide set of concerns and demographics. In addition to the Demographic Index, the EJSCREEN tool integrates 11 environmental pollution and 6 demographic indicators. Due to the numerous factors considered by the EJSCREEN tool, the Department provides only generalized information in this TMDL. Local communities can identify and prioritize other environmental justice concerns for their watershed.

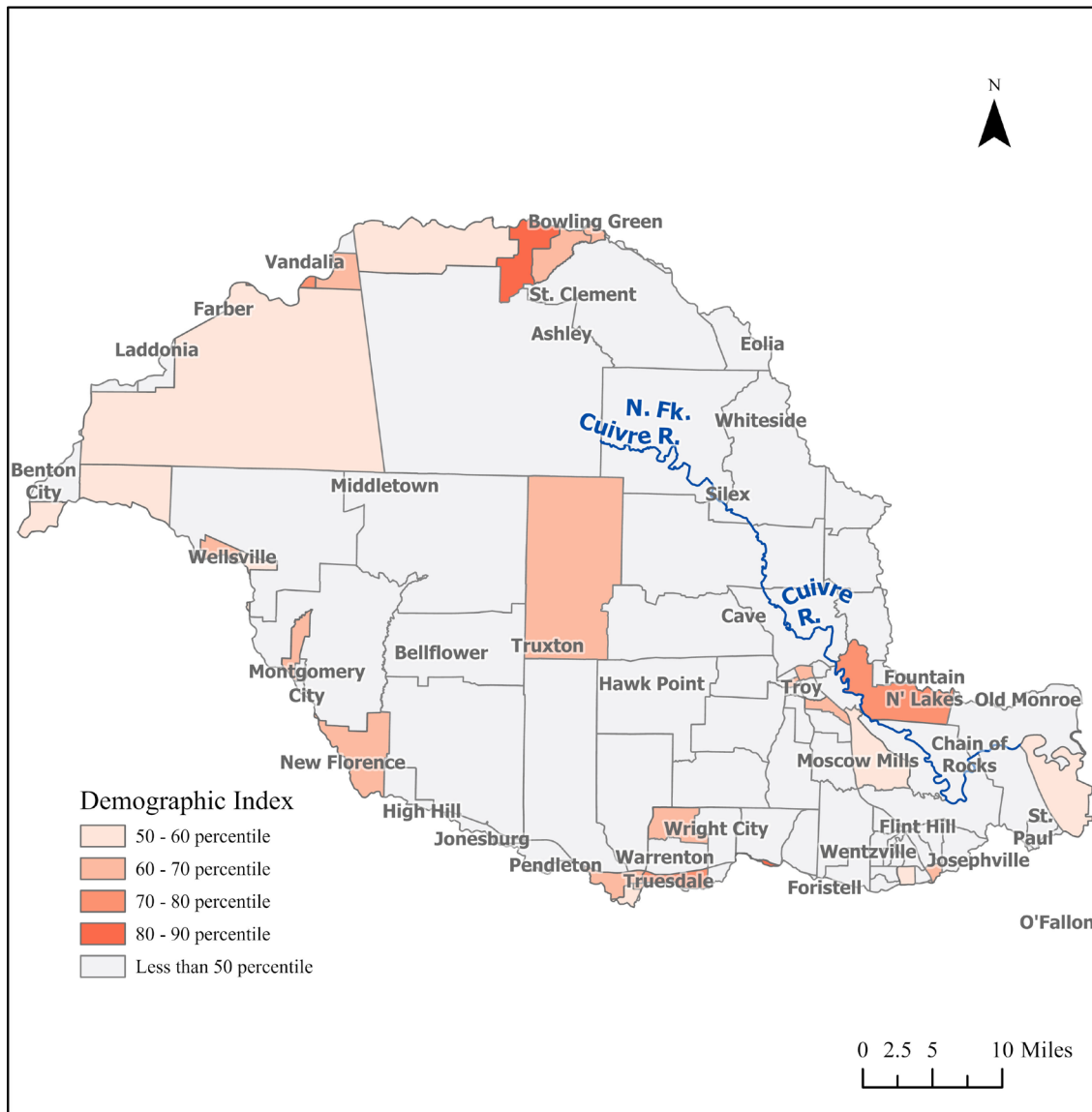


Figure 6. Demographic Index of the Cuivre River Watershed by Census Block Groups

2.4 Land Cover

A land cover analysis was completed using the 2019 National Land Cover Database published by USGS (Dewitz 2021). Land cover types present in the North Fork Cuivre River and Cuivre River watersheds are summarized in Tables 4 and 5. Figure 7 depicts the distribution of the land cover types throughout the watershed. Agricultural land (cultivated crops and hay/pasture) account for 65 percent of the Cuivre River watershed and 67 percent of the North Fork Cuivre River.

Table 4. Land Cover in the Cuivre River Watershed

Land Cover Type	Area Square miles	Percent
Developed, High Intensity	3.55	0.29
Developed, Medium Intensity	14.66	1.19
Developed, Low Intensity	31.38	2.55
Developed, Open Space	36.34	2.95
Barren Land	1.75	0.14
Cultivated Crops	550.09	44.68
Hay/Pasture	245.29	19.92
Shrub and Herbaceous	6.17	0.50
Forest	316.80	25.73
Wetlands	18.28	1.48
Open Water	6.77	0.55
Totals	1,231.09	100.00%

Table 5. Land Cover in the North Fork Cuivre River Watershed

Land Cover Type	Area Square miles	Percent
Developed, High Intensity	0.34	0.10%
Developed, Medium Intensity	1.98	0.59%
Developed, Low Intensity	6.23	1.85%
Developed, Open Space	7.36	2.18%
Barren Land	0.33	0.10%
Cultivated Crops	135.88	40.31%
Hay/Pasture	92.48	27.43%
Shrub and Herbaceous	1.44	0.43%
Forest	87.07	25.83%
Wetlands	3.29	0.98%
Open Water	0.73	0.22%
Totals	337.13	100.00%

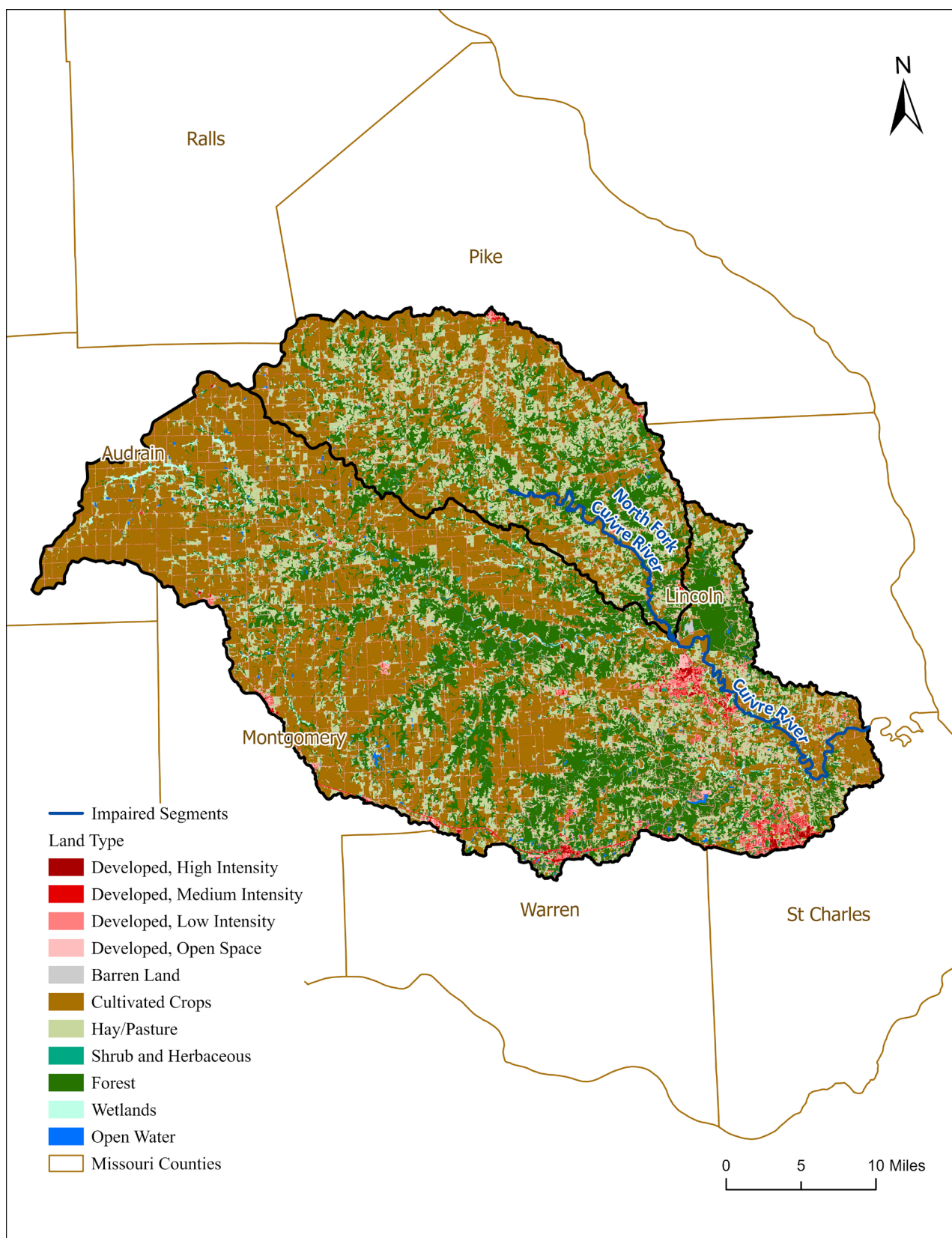


Figure 7. Land Cover in Cuivre River and North Fork Cuivre River Watersheds

3. Applicable Water Quality Standards

TMDLs identify the maximum pollutant load that a water body can assimilate and still attain and maintain water quality standards. Water quality standards are therefore central to the TMDL development process. Under the federal Clean Water Act, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters (U.S. Code Title 33, Chapter 26, Subchapter III). Water quality standards consist of three major components: designated uses, water quality criteria, and an antidegradation policy. In accordance with federal regulations at 40 CFR 131.10(b), Missouri's Water Quality Standards for each individual water body also provide for the attainment and maintenance of water quality in any downstream waters. Revising existing water quality standards is not within the purview of TMDL development. If future water quality monitoring demonstrates that existing water quality standards are not protective of individual water bodies or downstream uses, new water quality standards can be proposed in accordance with the guidance provided in EPA's Water Quality Standards Handbook.⁷

3.1 Designated Uses

Missouri's Water Quality Standards at 10 CSR 20-7.031(1)(C) defines designated uses that are assigned to individual water bodies in accordance with 10 CSR 20-7.031(2) and are listed in 10 CSR 20-7.031, Table G (Lakes) and Table H (Streams). Missouri's Water Quality Standards designate the following uses of Cuivre River and North Fork Cuivre River:

- Irrigation;
- Livestock and wildlife protection;
- Human health protection;
- Warm water habitat (aquatic life);
- Whole body contact recreation category A; and
- Secondary contact recreation.

The whole body contact recreation category A designated uses of Cuivre River and North Fork Cuivre River are impaired due to high *E. coli* bacteria concentrations. Whole body contact recreation includes activities that involve direct human contact with waters of the state to the point of complete body submergence (10 CFR 20-7.031(1)(F)2.A.). During whole body contact activities, such as swimming, accidental ingestion of the water may occur and there is direct contact to sensitive body organs, such as the eyes, ears, and nose. Whole body contact category A applies to waters that have been established by the property owner as public swimming areas and waters with documented existing whole body contact recreation uses by the public (10 CSR 20-7.031(1)(F)2.A.(I)). Secondary contact recreation, which includes activities such as boating, fishing, and wading, are activities that may result in contact with the water that is either incidental or accidental and the probability of ingesting appreciable quantities of water is minimal (10 CSR 20-7.031(1)(F)2.B.). The secondary contact recreation uses are not impaired in Cuivre River and North Fork Cuivre River.

3.2 Water Quality Criteria

Water quality criteria represent a level of water quality that supports and protects particular designated uses. Water quality criteria are expressed as specific numeric criteria and as general narrative statements. Missouri's Water Quality Standards (10 CSR 20-7.031(4) and (5)) establish

⁷ <https://www.epa.gov/wqs-tech/water-quality-standards-handbook>

general criteria applicable to all waters of the state at all times and specific criteria applicable to waters contained in 10 CSR 20-7.031, Tables G and H. Specific numeric *E. coli* bacteria criteria are given in Missouri’s Water Quality Standards at 10 CSR 20-7.031(5)(C) and Table A1. For whole body contact recreation category A waters, *E. coli* concentrations during the recreational season (April through October) shall not exceed the geometric mean of 126 colony forming units (cfu) per 100 milliliters (mL) of water. For losing streams segments, the *E. coli* count shall not exceed 126 cfu/mL at any time. These criteria are also protective of secondary contact recreational uses.

3.3 Antidegradation Policy

Missouri’s Water Quality Standards include the EPA “three-tiered” approach to antidegradation and may be found at 10 CSR 20-7.031(3).

Tier 1 – Protects public health, existing instream water uses, and a level of water quality necessary to maintain and protect existing uses. Tier 1 provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 28, 1975, the date of EPA’s first water quality standards regulations related to existing uses.

Tier 2 – Protects and maintains the existing level of water quality where it is better than applicable water quality criteria. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economic and social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the “fishable/swimmable” uses and other existing uses.

Tier 3 – Protects the quality of outstanding national and state resource waters. Such waters are identified in 10 CSR 20-7.031 Tables D and E. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality.

Waters in which a pollutant is at, near, or exceeds the water quality criteria are considered in Tier 1 status for that pollutant. Therefore, the antidegradation goals for Cuivre River and North Fork Cuivre River are to restore water quality to levels that meet water quality standards.

4. Defining the Problem

E. coli are bacteria found in the intestines of humans and warm-blooded animals and are used as indicators of potential fecal contamination and risk of pathogen-induced illness to humans. In accordance with Missouri’s 2022 Listing Methodology Document, the whole body contact recreation category A designated uses for Cuivre River and North Fork Cuivre River are impaired because the geometric means of *E. coli* samples collected during the recreational season from April 1 to October 31 were greater than 126 cfu/100 mL in the most recent three years having available data with five or

more samples.⁸ Sufficient data consistent with the assessment methodology are available to support these listings as summarized in Table 6 and Figure 8. As shown, *E. coli* concentrations exceeded the geometric mean of 126 cfu/100 mL in Cuivre River in 2017 and North Fork Cuivre River in 2013, 2014, 2015, and 2021. Although fewer than five samples were collected from Cuivre River in 2020 and North Fork Cuivre River in 2016 and 2022, measured *E. coli* concentrations were high in those years and were greater than the *E. coli* criterion concentration.

Individual *E. coli* measurements are provided in Appendix B to illustrate the nature of the impairment but were not used in the calculation of TMDL loading capacities or allocations. Individual measurements may be used to estimate pollutant reduction targets, to target implementation activities, and to select appropriate best management practices. Reduction targets for Cuivre River and North Fork Cuivre River are presented in a supplemental TMDL implementation strategies document available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls

Table 6. Summary of Recreational Season *E. coli* Data for the Impaired Water Bodies⁹

Water Body	Recreational Season	Number of Samples	Min (cfu/100 mL)	Max (cfu/100 mL)	Geometric Mean (cfu/100 mL)
Cuivre River (WBID 152)	2017	9	13	4,839	282
	2018	9	14	4,839	83
	2019	5	5	120	35
	2020	2	16	210	Insufficient Data
	2021	2	240	5,500	Insufficient Data
	2022	2	240	600	Insufficient Data
North Fork Cuivre River (WBID 158)	2013	13	20	4,839	190
	2014	14	71	1,986	379
	2015	7	272	4,839	662
	2016	3	579	4,839	Insufficient Data
	2021	15	34	4,839	340
	2022	3	4,839	4,839	Insufficient Data

* For water quality assessment purposes, geometric means are calculated only for years having a minimum of five samples

⁸ Listing Methodology documents are available online at dnr.mo.gov/document-search/methodology-development-2022-section-303d-list-missouri

⁹ *E. coli* data may be reported in units of most probable number (MPN) or colony forming units (cfu) depending upon the analysis method used. Data reported as cfu is an actual count of bacteria colonies, whereas MPN is a statistical approximation. Although differences may exist, they are often used interchangeably. For purposes of this TMDL, all *E. coli* data are presented in units of cfu regardless of the methodology used for simplicity and in order to maintain consistency with Missouri Water Quality Standards.

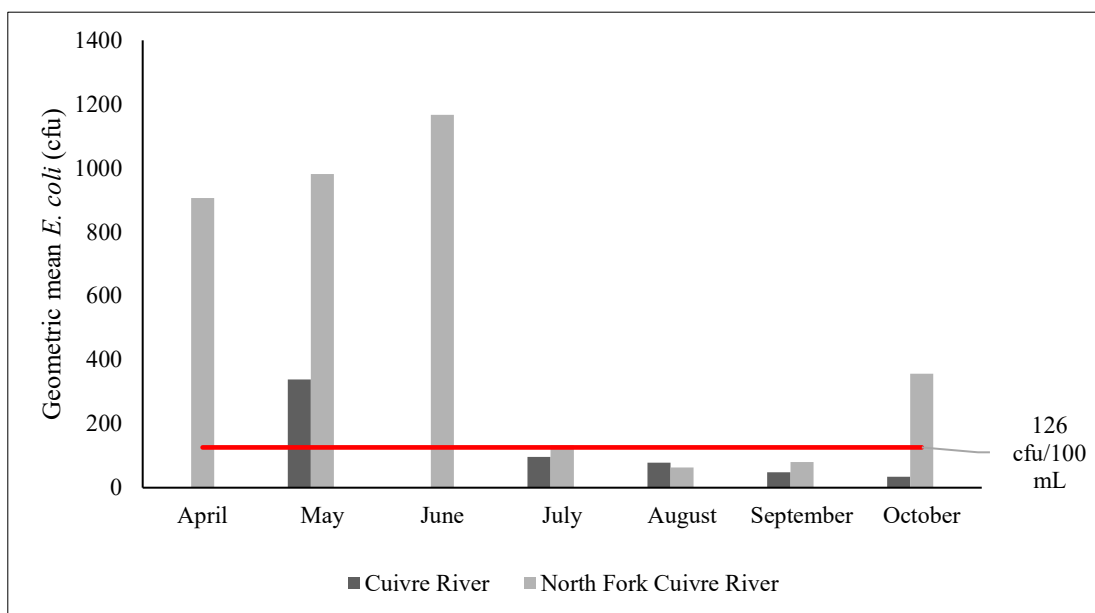


Figure 8. Geometric Means of *E. coli* Data by Month (Includes years with <5 samples and includes data from 2010 to 2022)¹⁰

5. Source Inventory and Assessment

Point (typically regulated) and nonpoint (typically unregulated) sources may contribute to the elevated *E. coli* concentrations in the impaired water bodies. The following source inventory and assessment identifies and characterizes known, suspected, and potential sources of bacteria loading to Cuivre River and North Fork Cuivre River. Sources of bacteria loading are identified and quantified to the extent that information is available.

5.1 Point Sources

Point sources are defined by Section 644.016(16) of the Missouri Clean Water Law and are regulated pursuant to the National Pollutant Discharge Elimination System through the Missouri State Operating Permit program.¹¹ A point source is defined as “any discernible, confined, and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. Point source does not include agricultural storm water discharges and return flows from irrigated agriculture.” Based on this definition, point sources include domestic wastewater treatment facilities, industrial and commercial facilities, concentrated animal feeding operations (CAFOs), MS4s, and stormwater discharges from industrial areas and construction sites. Illicit straight pipe discharges are also point sources but are illegal and therefore unpermitted. Pollutant loading from point sources is typically most evident during low-flow conditions when stormwater influences are lower or nonexistent. The locations of permitted point sources in the Cuivre River and North Fork Cuivre River watersheds are presented

¹⁰ There were no available *E. coli* data in April and June in the Cuivre River from 2010 to 2022.

¹¹ The Missouri State Operating Permit program is Missouri’s program for administering the federal National Pollutant Discharge Elimination System (NPDES). Generally, the Clean Water Act requires all point sources that discharge pollutants to waters of the United States to obtain an NPDES permit. Issued and proposed operating permits are available online at dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/wastewater

in Figure 9.¹² Facilities and their expected contributions to the impaired streams are described individually in the following sections.

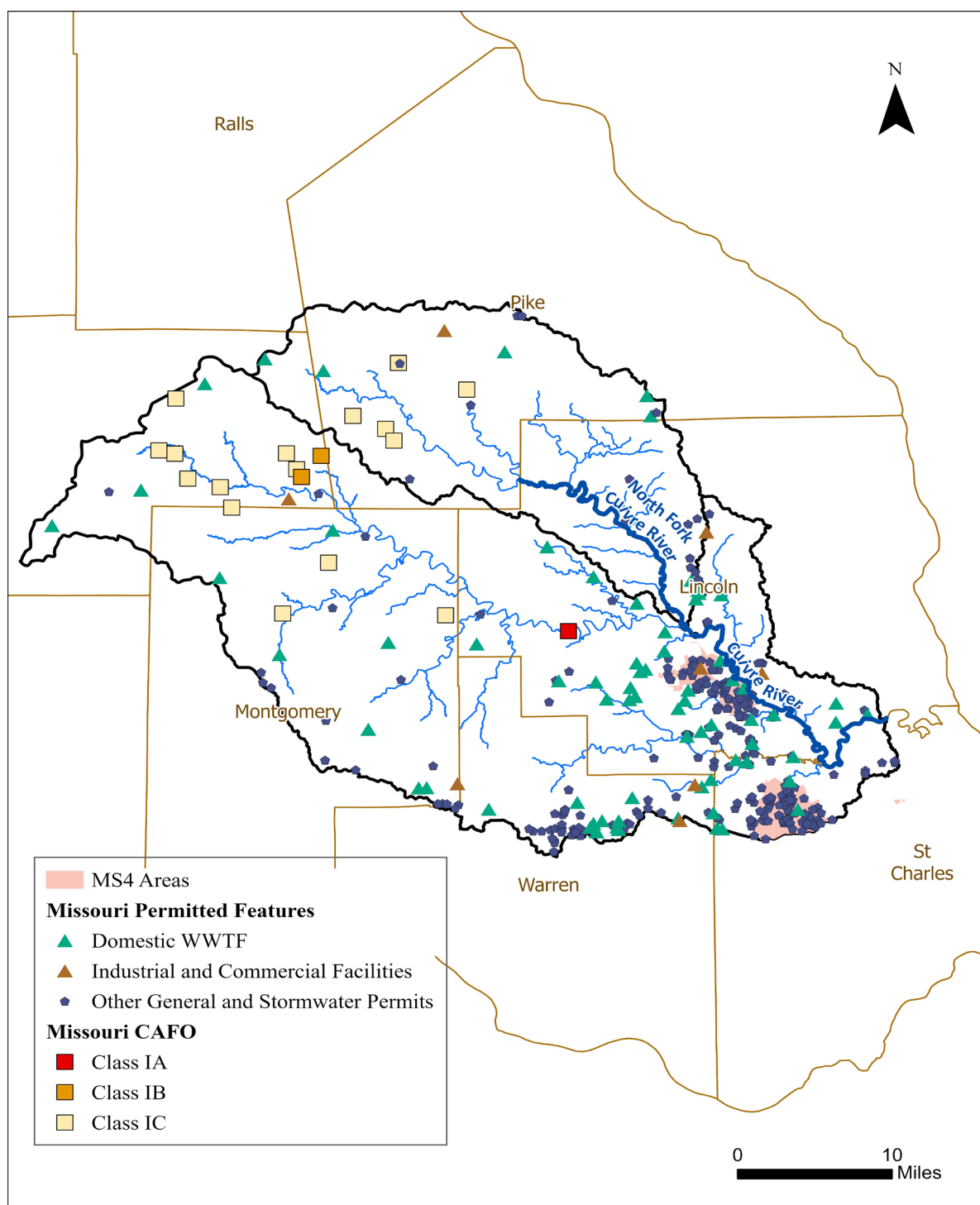


Figure 9. Permitted Features and Outfalls in the Cuivre River Watersheds

¹² Each marker on the map represents an outfall. There may be multiple outfalls per facility.

5.1.1 Domestic Wastewater Treatment Facilities

Domestic wastewater is primarily household waste, including graywater and sewage. Domestic wastewater treatment facilities include both publicly owned (municipal and sewer districts) and privately owned facilities. Untreated or inadequately treated domestic wastewater discharges can be significant sources of bacteria to receiving waters (USEPA 1986). When operating as designed, facilities utilizing disinfection technologies discharge *E. coli* at very low concentrations and are not expected to cause or contribute to bacteria impairments through discharges of treated effluent. Facilities that use effluent for irrigation (land application) or otherwise do not directly discharge to streams during the recreational season are also not expected to cause or contribute to *E. coli* impairments when all permit conditions are met.

There are 68 domestic wastewater treatment facilities or plants (WWTFs or WWTPs) within the Cuivre River watershed and nine of those are also within the North Fork Cuivre River watershed (Table 7). The cities of Bellflower, Farber, Hawk Point, Jonesburg, Middleton, Montgomery, Moscow Mills, Troy, Warrenton, Wellsville, and Wentzville operate municipal domestic wastewater treatment facilities in the Cuivre River watershed. Additionally, the Villages of Benton City, Eolia, Silex, and Truxton operate public domestic wastewater treatment facilities. Eolia, Silex, and Truxton are within the North Fork Cuivre River watershed.

10 CSR 20-7.015 requires recreational season *E. coli* limits for all domestic wastewater treatment facilities within two miles upstream of waters with whole body contact designated uses. Eight facilities currently have schedule of compliance to meet *E. coli* limits. Three facilities land apply wastewater for irrigation and two facilities do not discharge. The rest of the WWTFs or WWTPs have permits that contain *E. coli* limits protective of whole body contact recreation. Sixteen facilities within the Cuivre River watershed have had instances of non-compliance within the past five years (Table 8). While not all issues of non-compliance cause or contribute to the *E. coli* impairment, some instances including exceeding permit limit and unauthorized discharges can contribute to the impairment. There are no reported violations of permit requirements for WWTFs or WWTPs within the North Fork Cuivre River watershed. There are two facilities that operate under the MOGD general permit. The MOGD permit is for non-publically owned facilities that discharge less than 50,000 gallons per day. These facilities are required to meet *E. coli* effluent limits.

Table 7. Domestic Wastewater Treatment Facilities in the Cuivre River Watersheds

Permit Number	Facility Name	Schedule of Compliance to meet <i>E. coli</i> limits	Disinfection or Membrane Bioreactor (y/n)	Permit Expiration ¹³	Design Flow (GPD)	General Treatment Type
Cuivre River Watershed						
MO0113786	16200 Veterans Memorial East WWTF	y, 2023	n	12/31/23	3,000	Lagoon
MO0103764	Bellflower WWTF	y, 2026	n	3/31/24	60,000	
MO0117269	Country Cove Mobile Home Park WWTF	n	n	12/31/23	18,700	
MO0081574	Jonesburg Gardens WWTF	n	n	6/30/24	18,800	
MO0040851	Jonesburg WWTF	n	n	6/30/24	120,000	
MO0099228	LCPWSD No. 1 Green Acres WWTF	y, 2024	y	9/30/23	55,800	
MO0116262	Lindemann Hometown Court WWTF	n	y	9/30/23	25,200	
MO0116106	Lindemann Mobile Home Park WWTF	n	y	1/31/23	5,000	
MO0055387	Middletown City WWTF	y, 2025	y	6/30/24	8,220	
MO0119709	Moscow Mills - NW Area WWTF	n	y	3/31/24	999,990	
MO0125172	Prairie Meadow Subdivision WWTF	n	n	12/31/23	2,800	
MO0126381	Quail Run Mobile Home Park WWTF	n	y	12/31/23	130,000	
MO0087211	Roy L. Utilities WWTF	n	y	6/30/24	19,000	
MO0118192	Truxton WWTF	n	y	3/31/24	12,000	
MO0103021	Village of Benton City WWTF	y, 2025	n	9/30/23	20,000	
MO0050695	Wellsville East WWTF	y, 2028	n	12/31/23	158,000	
MO0136441	Community R-VI School WWTF	n	NA	3/31/24	5,850	Land Application
MO0108715	Anchor House of Warren County WWTF	n	n	6/30/24	3,650	Mechanical Plant
MO0129356	Auburn Lake WWTF	n	y	7/31/22	90,280	
MO0122971	Bennington WWTF	n	y	11/30/23	24,000	
MO0112542	Big Creek Estates WWTF	n	y	12/31/23	15,900	
MO0131261	Elm Tree Estates Home Owners Association WWTF	n	y	3/31/24	37,000	

¹³ When an NPDES permit expires, the permittee remains bound by the conditions of that expired permit until either the permit is terminated or a new permit is issued.

Permit Number	Facility Name	Schedule of Compliance to meet <i>E. coli</i> limits	Disinfection or Membrane Bioreactor (y/n)	Permit Expiration ¹³	Design Flow (GPD)	General Treatment Type
Cuivre River Watershed						
MO0098060	Fabick Foristell WWTP	n	y	12/31/23	9,000	
MO0129721	Faith Christian Family Church WWTF	n	n	12/31/23	5,500	
MO0107816	Flying J No. 674 WWTP	n	y	6/30/24	24,000	
MO0128171	Glenmeadows WWTF	n	y	12/31/23	80,000	
MO0045497	GSA Camp Tuckaho WWTP	n	y	9/30/23	15,000	
MO0134309	Keystone Estates WWTP	n	y	9/30/23	13,700	
MO0130125	Majestic Lakes WWTP	n	y	12/31/23	79,000	
MO0131211	MAWC Anna Meadows Subdivision WWTP	n	y	12/31/23	62,500	
MO0098817	MAWC Incline Village WWTF No. 1	n	y	12/31/23	80,000	
MO0132373	MAWC Jaxson Estates WWTP	n	y	12/31/23	150,000	
MO0100358	MAWC Warren-Lincoln County No. 2 WWTP	n	y	12/31/23	80,000	
MO0084158	Montgomery City East WWTP	n	y	9/30/23	500,000	
MO0129852	Moscow Mills Crooked Creek WWTP	n	y	12/31/23	1,200,000	
MO0109673	North Oak Sewer District WWTP	n	n	11/30/23	50,000	
MO0128775	Norton Woods Sewage Treatment	n	y	9/30/23	55,300	
MO0138312	Oakwind Estates WWTP	n	y	9/30/23	25,000	
MO0109495	Orchard Farm Park WWTP	n	y	12/31/23	11,900	
MO0134180	Pear Tree Property WWTP	n	y	12/31/23	4,200	
MO0110680	Pleasant Oak Mobile Home Park WWTP	n	y	12/31/23	19,000	
MO0122378	Red Hawk Estates Mobile Home Park WWTF	n	y	11/30/22	62,000	
MO0132497	Rockport Subdivision WWTP	n	y	12/31/23	78,000	
MO0136204	SCCPWSD 2 Hickory Trails WWTP	n	y	12/31/23	600,000	
MO0133264	SCCPWSD#2 Providence Estates WWTP	n	y	3/31/24	250,000	
MO0054623	Troy Hwy 47 WWTP	n	y	3/31/24	1,300,000	
MO0131296	Troy Southeast WWTP	n	y	3/31/24	1,870,000	

Permit Number	Facility Name	Schedule of Compliance to meet <i>E. coli</i> limits	Disinfection or Membrane Bioreactor (y/n)	Permit Expiration ¹³	Design Flow (GPD)	General Treatment Type
Cuivre River Watershed						
MO0087912	Warrenton WWTP	y, 2024	n	12/31/23	3,200,000	No Discharge
MO0093599	Wentzville Water Reclamation Center	n	y	3/31/24	5,340,000	
MOGD00407	Westborough Estates WWTP	n	y	6/30/24	28,000	
MO0055409	Farber WWTF	n	NA	12/31/23	0	
MO0028053	Hawk Point WWTF	n	NA	9/30/23	0	
MO0113387	Country Horizon Mobile Home Park WWTP	n	n	12/31/23	3,300	Sand/Rock Filter
MO0116343	Deer Run Meadows WWTP	n	y	3/31/24	5,200	
MO0125644	Hickory Farms Subdivision WWTF	n	y	9/30/23	4,800	
MO0132047	North Moore Estates WWTF	n	y	3/31/24	9,750	
MO0135551	Renae Aldein WWTP	n	y	12/31/23	4,000	
MO0118087	Oakwood Mobile Home Park	n	n	4/16/14	1,100	Septic Tank
MO0113042	Shannon's Little River Farm	n	n	12/31/18	3,000	
North Fork Cuivre River and Cuivre River Watersheds						
MO0108243	Silex WWTF	n	n	12/31/27	22,696	Lagoon ¹⁴
MOG823091	Big Larrys Campground WWTF	NA	NA	8/24/27	0	Land Application
MO0112470	Eolia WWTF	NA	NA	12/31/23	39,000	
MO0119385	Charwood Estates WWTP	n	y	12/31/23	9,990	Mechanical Plant
MOGD00456	L and L Mobile Home Park WWTF	n	y	6/30/24	5,000	
MO0129984	Lazy Acres Subdivision WWTP	n	y	3/31/24	10,000	
MOGD00362	Cedar Ridge Estates WWTP	n	y	6/30/24	3,500	Sand/Rock Filter
MO0128872	North Troy Business Park WWTP	n	y	12/31/23	5,400	
MOG823118	Aviary Recovery Center	NA	NA	8/24/27	6,100	Septic Tank/Land Application

¹⁴ Silex WWTF is a no discharge, subsurface dispersal system and holds a permit that allows discharge when the irrigation system is overloaded.

Table 8. Compliance issues from 2017 to 2022 for domestic WWTFs within the Cuivre River watershed¹⁵

Permit Number	Time Under Enforcement	Reason
MO0028053	8/28/13 - 5/4/21	failure to meet permit limits, failure to upgrade facilities
MO0050695	12/20/11 - 10/29/18	failure to comply to permit conditions, failure to meet permit limits, failure to upgrade facilities, failure to submit required reports
MO0087211	1/31/19 - 2/3/21	violated effluent requirements
MO0099228	6/11/15 - 5/19/17	caused pollution to waters of the state, failure to meet permit limits, violated water quality standards
MO0109673	7/25/13 - 2/4/19	caused pollution to waters of the state, operation without a required permit, failure to implement/maintain permit requirement.
MO0110680	7/11/16 - 2/21/20	failure to meet permit limits
MO0113042	11/2/17 - present	delinquent permit fees
MO0113387	2/22/19-04/15/22	failure to renew or expired permit, violated effluent requirements
MO0122971	12/23/21 - present	caused pollution to waters of the state, permit limits, violated water quality standards
MO0125172	9/29/15 - 4/5/17	caused pollution to waters of the state, delinquent permit fees, failed to comply with previous notice of violation, failure to operate and maintain WWTF failure to submit DMRs, illegal discharge of wastewater/sediment, operation without a required permit, violated water quality standards
MO0126381	07/27/22 - present	not listed
MO0128121	12/15/09 - 2/23/17	failed to apply for/obtain required permit, failure to implement/maintain permit. Requirement, failure to renew or expired permit.
MO0129356	1/31/19 - 9/10/21	failure to comply with the permit condition
MO0130125	12/15/08 - 01/30/20	caused pollution to waters of the state, violated effluent requirements
MOG821103	2/15/2013 - 12/02/20	violated subdivision requirements
MOG822015	5/30/17 - 4/10/18	unpermitted discharge from lagoon resulting in a fish kill
MO0108243	4/8/15 - present	Failed to upgrade facilities, caused pollution to waters of the state, failed to meet permit limits, failed to submit DMRs

Potential bacteria loading from domestic WWTFs may also occur from sanitary sewer overflows. Sanitary sewer systems convey residential wastewater, and in some cases commercial and industrial wastewater, to the domestic WWTF. Sanitary sewer systems can handle limited amounts of inflow from stormwater and infiltration from groundwater, but are typically not designed to collect large amounts of runoff from precipitation events. Overflows from sanitary sewer systems may result in elevated bacteria counts in nearby surface waters (USEPA 1996). Sanitary sewer overflows can be caused by high volume precipitation events and can also occur during dry weather due to blockages, line breaks, sewer defects, power failures, and vandalism. Sanitary sewer overflows can occur at any point in the collection system, but are typically evident by overflowing manholes and backups into private residences. Such overflows may discharge directly to nearby waterways or may be restricted

¹⁵ Not all instances of non-compliance cause or contribute to the *E. coli* impairment

to terrestrial locations. These discharges are not authorized by the federal Clean Water Act or the Missouri Clean Water Law.

Table 9 summarizes reported sanitary sewer overflows that occurred during the recreational season between 2018 and 2022. Three facilities reported bypasses on July 26, 2022, which was a record heavy precipitation event. Sanitary sewer overflows are not expected to cause or contribute to the *E. coli* impairments in the Cuivre River or North Fork Cuivre River because the unintentional discharge of untreated domestic wastewater in these watersheds has been infrequent and temporary in nature. Missouri State Operating permits and 40 CFR Part 122.41(e) require permittees to properly operate and maintain their facility's collection systems. This is implemented through a special permit condition or schedule of compliance.

Table 9. Reported bypasses from 2018 to 2022

Watershed	Permit Number	Facility	Bypass Date (month/day/year)
Cuivre River	MO0129356	Auburn Lake WWTP	4/3/20
	MO0136204	SCCPWSD 2 Hickory Trails WWTP	7/10/21
	MO0109673	North Oak Sewer District WWTP	8/30/21
	MO0112542	Big Creek Estates WWTP	7/26/22
	MO0131211	MAWC Anna Meadows Subdivision WWTP	7/26/22
	MO0132373	MAWC Jaxson Estates WWTP	7/27/22
	MO0129852	Moscow Mills Crooked Creek WWTP	8/21/22
	MO0054623	Troy Hwy 47 WWTP	9/18/18
	MO0087211	Roy L. Utilities WWTF	6/28/21, 7/12/21, 4/21/22
	MO0131296	Troy Southeast WWTP	4/11/19, 5/2/19, 6/28/19
	MO0131261	Elm Tree Estates HOA WWTP	4/14/22
	MO0133264	SCCPWSD#2 Providence Estates WWTP	8/14/18
	MO0028053	Hawk Point WWTF	8/21/2018, 6/30/21-7/5/21; 7/12/21
	MO0087912	Warrenton WWTP	9/26/18, 10/9/18, 6/4/19, 6/26/21
Cuivre River and North Fork Cuivre River	MO0112470	Eolia WWTF	5/19/20
	MO0108243	Silex WWTF	7/6/18-7/10/18

5.1.2 Industrial and Commercial Facilities

Industrial and commercial facilities discharge process water used or generated during mining, manufacturing, or food processing activities, and may also include landfills. Mining and manufacturing facilities are not expected to cause or contribute to bacteria impairments. Food processing wastewater and those associated with biosolid wastes may contain bacteria. There are 12 general permitted industrial or commercial facilities and two site-specific permitted facilities within

the Cuivre River watershed. Two of the general permitted facilities and one of the site-specific permitted facilities are within the North Fork Cuivre River watershed. These facilities are listed on Table 10. The two facilities that operate under site-specific permits, the St. Louis West Travel Center, Incline Village, and City of Troy Swimming Pool are unlikely to cause or contribute to bacteria impairments because they disinfect. The other facilities all operate under a no discharge permit and/or land application of biosolids. When all permit conditions are met they are not expected to cause or contribute to the *E. coli* impairments in the Cuivre River and North Fork Cuivre River.

Table 10. Industrial and Commercial Facilities

Watershed	Permit ID	Facility	Expiration	Effluent Type
Cuivre River	MO0128121	Stone Ridge Canyon	12/26/07	Stormwater
	MOG140017	St Louis West Travel Center	6/30/24	Non-Domestic Process/Incidental Stormwater
	MOG690021	Incline Village	7/31/24	Non-Domestic Process Water
	MOG760141	City of Troy Swimming Pool	7/31/24	Non-Domestic Process Water
	MOG821041	Masterson and Associates North	11/30/22	Sludge/Biosolids
	MOG821103	B and J Septic Pumping LLC	11/30/22	Sludge/Biosolids
	MOG821212	Mick Mehler and Sons, Inc.	11/30/22	Sludge/Biosolids
	MOG822015	Davis Meat Processing LLC	5/22/22	Non-Domestic Process Water
	MOG822102	Farmers Butchering and Processing	5/22/22	Non-Domestic Process Water
	MOG822167	Wright City Meat Company Inc	5/22/22	Non-Domestic Process Water
Cuivre River and North Fork Cuivre River	MOG822233	M and M Country Butchering	5/22/22	Non-Domestic Process Water
	MO0000710	Harbison-Walker Refractories Vandalia Pl	3/31/24	Non-Domestic Process/Incidental Stormwater
	MOG822023	Hiltys Custom Meats	5/22/22	Non-Domestic Process Water
	MOG822211	Browns Processing	5/22/22	Non-Domestic Process Water

5.1.3 Concentrated Animal Feeding Operations

Animal waste generated from CAFOs can be a source of bacteria to water bodies (Rogers and Haines 2005). Pursuant to 10 CSR 20-6.300, permits are required for CAFOs that confine and feed or maintain more than 1,000 animal units for 45 days or more during any 12-month period.¹⁶ Permits may be required for facilities with fewer animal units if pollutants are discharged directly

¹⁶ As defined by 10 CSR 20-6.300(1)(B)2, an animal unit is a unit of measurement to compare various animal types at an animal feeding operation. One (1) animal unit equals the following: 1.0 beef cow or feeder, cow/calf pair, veal calf, or dairy heifer; 0.5 horse; 0.7 mature dairy cow; 2.5 swine weighing over 55 pounds; 10 swine weighing less than 55 pounds; 10 sheep, lamb, or meat and dairy goats; 30 chicken laying hens or broilers with a wet handling system; 82 chicken laying hens without a wet handling system; 55 turkeys in grow-out phase; 125 chicken broilers, chicken pullets, or turkey poults in brood phase without a wet handling system.

into waters of the state or other water quality issues are discovered. In Missouri, CAFOs operate under site-specific permits or one of two general permits (MOG01 or MOGS1). All CAFO facilities are permitted as no-discharge facilities. The MOGS1 permit and site-specific permits for the Lincoln County Egg Farm facility and Ashley Facility -EFI do not authorize discharges for any reason. The MOG01 permit allows discharge only in the event of weather that exceeds the criteria of a catastrophic storm, and only authorizes discharge of the portion of stormwater flow that exceeds the design storm event, which includes the direct precipitation and runoff from the 25-year, 24-hour storm event. These discharges are not expected to be significant contributors of *E. coli* to surface waters because they are rare and temporary in nature, and may only occur during the defined catastrophic storm events that generally result in high flows that are infrequently met or exceeded.

Sixteen Class IC facilities, one class IA, and two class IB CAFO facilities are present in the Cuivre River watershed.¹⁷ Table 11 lists the CAFO facilities by watershed. Fourteen CAFOs operate under a MOGS1 general permit, four operate under a MOG01 general permit and one under a site-specific permit. Animal waste applied on areas under the control of a CAFO are subject to conditions found in the permit, which include a requirement for the CAFO to develop a nutrient management plan. Discharge during land application is prohibited. Section 640.760 Revised Statutes of Missouri (RSMo) establishes setback distances for surface application of liquefied manure from a CAFO by a third party.¹⁸

Two CAFOs in the Cuivre River watershed are currently under enforcement. Ruether Brothers and Sons, LLC is under enforcement for failing to comply with the permit limit and Cin-Way LLC – Homiste is under enforcement for causing pollution to waters of the state resulting in a water pollution emergency. Within the past five years, there have been five other instances of non-compliance. In 2022, Parks Finishing C1 LLC, Lincoln County Egg Farm, and Peak Farms site 1 failed to comply with a permit condition. In 2020, Shannon Culwell caused pollution to waters of the state and failed to comply with a permit condition. CAFOs violating their permit conditions as they relate to discharge or land application are potential sources of *E. coli* and may be subject to Department enforcement action. When all permit requirements are met, CAFOs are not expected to be contributors through direct discharge of bacteria loading to the Cuivre River or the North Fork Cuivre River.¹⁹

¹⁷ An operation's "class size" is a category that is based upon the total number of animal units confined at an operation. The Class IC, IB, and IA are categories that start at 1,000, 3,000, and 7,000 animal units respectively, all of which are required by state regulation to obtain a permit. (1,000 animal units is equal to 2,500 swine; 100,000 broilers; 700 dairy cows; or 1,000 beef steers).

¹⁸ Section 640.760 RSMo requires all third party surface applicators of liquefied manure from CAFOs to maintain the following minimum setback distances: 50 feet from a property boundary, 300 feet from any public drinking water lakes, 300 feet from any public drinking water well or intake structure, 100 feet from any perennial and intermittent streams without vegetation abutting such streams, and 35 feet from any perennial and intermittent streams with vegetation abutting such streams.

¹⁹ Per Missouri Clean Water Law at 644.059 and 644.016(16) RSMo, and Missouri permit regulations at 10 CSR 20-6.300(1)(B)10, discharges of agricultural stormwater are separate from CAFO discharges and are considered nonpoint sources.

Table 11. Concentrated Animal Feeding Operations

Watershed	Permit Number	Facility Name	Expiration Date	Classification
North Fork Cuivre River	MOG010444	Ashley Facility - EFI	2/25/23	Class IC
	MOGS10044	Coleman Quality Pork, LLC	2/13/28	Class IC
	MOGS10296	Parks Finishing C1, LLC	2/13/28	Class IC
	MOGS10585	Star Hill Hog Farm, LLC	2/13/28	Class IC
	MOGS10621	Paradiso Dei Maiali	2/13/28	Class IC
Cuivre River	MO0107026	Lincoln County Egg Farm	8/31/22	Class IA
	MOGS10001	Barnes Hog Farm	2/13/28	Class IB
	MOGS10013	Shannon Culwell	1/28/23	Class IB
	MOG010455	Cherry Patch Facility - EFI	2/25/23	Class IC
	MOG010549	Peak Farms Site 1	2/25/23	Class IC
	MOG010581	Peak Farms Site 2	2/25/23	Class IC
	MOGS10050	M.C. Pork LLC	2/13/28	Class IC
	MOGS10075	Cin-Way LLC - Homesite	2/13/28	Class IC
	MOGS10278	Cin-Way LLC - Middle Site	2/13/28	Class IC
	MOGS10343	Cin-Way LLC, Stone site	2/13/28	Class IC
	MOGS10361	T and B Farms	2/13/28	Class IC
	MOGS10547	MC Pork Site 2	2/13/28	Class IC
	MOGS10569	Ruether Brothers and Sons, LLC	2/13/28	Class IC
	MOGS10594	Ruether Bros and Sons Farms, LLC	2/13/28	Class IC

5.1.4 Municipal Separate Storm Sewer Systems

Municipal separate storm sewer systems (MS4s) are stormwater conveyance systems owned by a public entity that are not part of a sanitary sewer system, a combined sewer system, or part of a domestic wastewater treatment facility. Federal regulations issued in 1990 require that discharges from MS4s be regulated by permits if the population of a municipality, or in some cases a county, is 100,000 or more. As of 1999, new federal regulations also require permits for discharges from small MS4s that are located within a U.S. Census Bureau defined urban area or are required to hold a MS4 permit based on other criteria by the permitting authority. As discussed in Section 2.3, at the time of the 2010 census, the U.S. Census Bureau designated one urban area in the Cuivre River watershed. The City of Wentzville is within this designated urban area and its MS4 is regulated by a general small MS4 permit (MOR04C075). The City of Troy is not within this urban area, but its MS4 discharges are also regulated by the small MS4 general permit (MOR04C053). St. Charles County has an MS4 permit (MOR040058) for the unincorporated areas that are within the designated urban area within St. Charles County. Table 12 lists the regulated MS4s within the Cuivre River watershed. Unregulated runoff from developed areas is considered a nonpoint source of pollution and is discussed in Section 5.2.2. The Missouri Department of Transportation (MoDOT) holds a site-specific transportation separate storm sewer system (TS4) permit (MO0137910) that applies to stormwater discharges within the urban areas. There are currently no regulated MS4s in the North Fork Cuivre River.

Table 12. MS4 area within Cuivre River watershed

Permit ID	Municipality	Area in Watershed (square miles)	Percent of Watershed
MOR04C075	Wentzville	9.570	0.777%
MOR04C053	Troy	7.347	0.597%
MOR040058	St. Charles County	3.306	0.269%
Total MS4 Area		20.223	1.643%

MS4 permits authorize the discharge of urban stormwater runoff. In general, urban runoff contains high levels of bacteria and may contribute to exceedances of *E. coli* criteria during and immediately after storm events in most streams throughout the country (EPA 1983). Runoff contaminated with *E. coli* flows from open areas where soil erosion is common and from heavily paved areas (EPA and Pitt 2002). For these reasons, urban runoff is a potential contributor of *E. coli* to Cuivre River.

Urban sourced bacterial loading to streams can be from sanitary sewer overflows, as discussed in Section 5.1.1 of this document, and from residential and green space runoff carrying domestic and wild animal waste. Birds, dogs, cats, and rodents are documented as common sources of *E. coli* in urban stormwater (Burton and Pitt 2002). Irrigation runoff from residential lawns where pet wastes are present may also contribute *E. coli* loads to surface waters. Due to available monitoring data showing high *E. coli* concentrations being collected upstream of areas contributing MS4 stormwater flows, and due to the relatively small proportion of the watershed contributing stormwater flows to MS4s (< 2 percent), MS4s are not expected to be a significant contributor to the impairment. Even so, permitted MS4s must continue to meet all specified permit conditions.

Another source of urban stormwater is runoff originating from highway corridors. The Federal Highway Administration published research identifying bird droppings, soil, and vehicles carrying livestock and stockyard wastes as sources that may periodically “seed” highway corridors with *E. coli* and other pathogens. The study further notes that the magnitude of contaminated runoff from highway systems are site-specific and can be affected by numerous factors, such as traffic, design, maintenance, land use, climate, and accidental spills (FHWA 1984). Due to the intermittent and potentially sporadic nature of highway bacterial contributions described in the federal study, as well as the small amount of MoDOT operated rights-of-way in the Cuivre River watershed, the MoDOT TS4 is not expected to be a significant contributor to the bacteria impairment in Cuivre River.

Although stormwater discharges are often untreated, MS4 permit holders must develop, implement, and enforce stormwater management plans to reduce the contamination of stormwater runoff and prohibit illicit discharges. Stormwater management plans must include measurable goals, annual reports, and six minimum control measures. These control measures include public education and outreach, public participation and involvement, illicit discharge detection and elimination, construction site runoff control, post-construction runoff control, and pollution prevention. MS4 permits may also require the development of supplemental TMDL Assumptions and Requirement Attainment Plans (ARAPs) where applicable. Missouri’s list of Regulated MS4s and associated stormwater management plans can be accessed at dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/stormwater/municipal-separate-storm-sewer-systems-ms4.

5.1.5 Other General Permitted Wastewater and Stormwater Discharges

General permits are issued for certain wastewater (MOG) and stormwater (MOR) discharges based on the type of activity and are intended to be flexible enough to allow for ease and speed of issuance, but must also protect water quality. General wastewater and stormwater permits are issued for activities similar enough to be covered by a single set of requirements. Table 13 lists other general and stormwater discharge permits in the Cuivre River and North Fork Cuivre River watersheds that have not already been discussed in other sections of this TMDL. Permits associated with construction or land disturbance activities (MORA) are temporary. The number of permits of this type may vary in any given year. Despite this variation, activities associated with general construction or land disturbance permits are not expected to cause or contribute to *E. coli* impairments when all permit conditions are met.

Existing and future activities for which general wastewater or stormwater permits are issued are expected to be conducted in compliance with all permit conditions including monitoring requirements and discharge limitations. Permit conditions are intended to protect the designated uses of all water bodies within the watershed. Activities conducted in accordance with general wastewater and stormwater permit requirements are not expected to contribute *E. coli* loads in amounts substantial enough to cause or contribute to surface water impairments. Per 10 CSR 20-6.010(13)(C), if at any time the Department determines that a general permit is not providing adequate water quality protection, the Department may require the owner or operator of a permitted site or activity to obtain a site-specific operating permit.

Table 13. Other General Wastewater and Stormwater Permits²⁰

Watershed	Permit ID	Facility Name	Date Permit Expires	Permit Type
Cuivre River	MOG350142	MFA Oil Bulk Plant Wright City	9/17/2027	Petroleum Storage
	MOG490036	Magruder Limestone Co Troy Quarry	4/30/2027	Limestone Quarries
	MOG490145	Crown Bedrock Quarry Division		
	MOG490389	NFMOA Auburn Stone		
	MOG490476	Moscow Mills Quarry CS-57		
	MOG490552	CHRISTY MINERALS LLC		
	MOG490616	Lincoln County Quarry		
	MOG490648	Schreiter Concrete Company		
	MOG490749	C J Concrete Products Inc		
	MOG490754	G and M Concrete and Asphalt Co Inc		
	MOG490813	Big Creek Quarry		
	MOG490814	EMC Plant 83 Moscow Mills		

²⁰ As of August 31, 2022

Watershed	Permit ID	Facility Name	Date Permit Expires	Permit Type
	MOG490906	BMC Stone Wright City		
	MOG490986	Schreiter Materials LLC		
	MOG491066	NFMOA Moscow Mills Asphalt		
	MOG491254	Lincoln County Concrete		
	MOG491330	CertainTeed		
	MOG840121	Christy Minerals LLC Clare Mine	6/30/2026	Clay Pits
	MOG840170	Christy Minerals LLC Walton Clay Pit		
	MOG840209	Christy Minerals LLC Rothermel		
	MOG840225	Thomas #4		
	MOG970052	Scotts MiracleGro	8/6/2023	Petroleum Impacted Water Remediation
	MOG970054	AgriCycle Jonesburg Farm		
	MOR203018	SAF Holland Inc	8/31/2024	Fabricating Metal/Light Industrial
	MOR203214	Toyota Motor Manufacturing Missouri Inc		
	MOR203255	Missouri Smelting Technology	8/31/2024	
	MOR60A006	Countryside Auto and Truck Parts	12/11/2023	Motor Vehicle Salvage
	MOR60A031	AUTO PARTS COMPANY		
	MOR60A343	Wright City Auto Sales		
	MOR60A359	PSC Metals Wright City Yard		
	MOR60A370	Warrenton Metal Recycling		
	MOR60A452	Scrap Mart Metals Jonesburg LLC		
	MOR80C022	WITTE BROS EXCHANGE INC	11/30/2027	Motor Freight Transportation
	MOR80C144	Jack Cooper Transport Company Inc	11/30/2022	
	MOR80C156	Creech Bros Warehousing and Dist Inc		
	MORA19725	Wentzville Water Reclamation Center	2/7/2027	Construction or Land Disturbance
	MORA19737	Wright City Park		

Watershed	Permit ID	Facility Name	Date Permit Expires	Permit Type
	MORA19785	WEST MEYER ROAD PHASE 3		Construction or Land Disturbance
	MORA19791	City of Warrenton		
	MORA19826	Sieh Storage		
	MORA19842	Prairie Wind		
	MORA19847	The Oaks at Lexington Phase 5		
	MORA19884	Wentzville Community Center		
	MORA19914	Manors of Magnolia/61 East Business Park		
	MORA19923	Stonebridge III and Villas		
	MORA19933	Westhaven Phase 2		
	MORA19934	Stone Crossing Ph 5 and 6		
	MORA19959	Orchard Grove		
	MORA19980	Park Hills Estates Phase 4		
	MORA20015	Community Solar Expansion Project		
	MORA20033	The Hills at Big Creek		
	MORA20110	Dollar General #24039 Troy MO		
	MORA20168	Crystal Creek Development		
	MORA20186	Wynncrest		
	MORA20227	Timber Trace PH4		
	MORA20245	The Embers At Troy		
	MORA20245	The Embers At Troy		
	MORA20276	Riverdale Villages B and E		
	MORA20278	Riverdale Village G		
	MORA20433	Good Game Sports Park		
	MORA20514	The Oaks at Lexington Phase Four		
	MORA20536	Lincoln County Storage		
	MORA21033	Praire Wind		
	MORA21036	MOTO, Inc.		
	MORA21073	Enon Substation Expansion		
	MORA21114	Providence Estates Phase 5 6 and 7		
	MORA21148	True Luck 2 LLC		

Watershed	Permit ID	Facility Name	Date Permit Expires	Permit Type
	MORA21162	Lone Wolf Acres - 2022		Construction or Land Disturbance
	MORA21181	New Park at Foristell		
	MORA21190	Sutton Farms - Lombardo		
	MORA21193	JJ Kane		
	MORA21200	Villages at Huntleigh Ridge Ph 2 Sta 1		
	MORA21248	Forest Ridge Subdivsion		
	MORA21258	Boone Street Commons		
	MORA21259	LCAD Base 2		
	MORA21265	BestBox Self Storage		
	MORA21346	Auburn Lakes		
	MORA21391	Lincoln County RIII South Elementary		
	MORA21438	Village at Indian Creek - Lincoln County		
	MORA21472	Moscow Bridge Farm		
	MORA21483	Stone Canyon		
	MORA21492	Weinand Farm		
	MORA21600	Orange Blossom Phase 3		
	MORA21610	Summit at Park Hills Plat 1		
	MORA21645	Chapelwood Place		
	MORA21665	Park Hills Plat 2 and 3		
	MORA21676	Raising Cane's #913 Wentzville, MO		
	MORA21716	City of Warrenton		
	MORA21821	Twin Oaks at Heritage Pointe Ph 2		
	MORA21923	Jaxson Estates Subdivision Plat 7		
	MORA22067	The Village at Indian Creek - SCC		
	MORA22102	Quiet Lake Estates		
	MORA22129	Mitchell Turpin		
	MORA22193	Cherry Street Improvements		
North Fork Cuivre River and	MOG350329	Ayerco #35	9/17/2027	Petroleum Storage
	MOG490102	Magruder Limestone Co., Ashley Quarry	4/30/2027	Limestone Quarries

Watershed	Permit ID	Facility Name	Date Permit Expires	Permit Type
Cuivre River	MOG490484	Troy Ready Mix and Material Co Inc	4/30/2027	
	MOG490486	Magruder Limestone Co Silex Quarry	4/30/2027	
	MOG490571	CHAMPION PRECAST, INC	4/30/2027	
	MOG491075	Davis Redi-Mix	4/30/2027	
	MOG840023	HarbisonWalker Tucker Property	6/30/2026	Clay Pits
	MOR80C588	COASTAL CARRIERS INC	11/30/2022	Motor Freight Transportation

5.1.6 Illicit Straight Pipe Discharges

Illicit straight pipe discharges of domestic wastewater are also potential sources of bacteria. These types of sewage discharges bypass treatment systems, such as septic tanks or sanitary sewers, and discharge directly to a stream or an adjacent land area (Brown and Pitt 2004). Illicit straight pipe discharges are illegal and are not authorized by the federal Clean Water Act or the Missouri Clean Water Law. At present, there are no data about the presence or number of illicit straight pipe discharges in the Cuivre River and North Fork Cuivre River watersheds. For this reason, it is unknown to what significance straight pipe discharges contribute bacteria loads to surface waters in the watershed. Due to the illegal nature of these discharges, any identified illicit straight pipe discharges must be eliminated. In areas with a regulated MS4, illicit discharge detection and elimination is a required permit condition.

5.2 Nonpoint Sources

Nonpoint sources are diffuse sources with no discernible, confined, or discrete conveyance, and include all categories of discharge that do not meet the definition of a point source. Nonpoint sources are not regulated by the federal Clean Water Act and are exempt from Department permit requirements by state regulation 10 CSR 20-6.010(1)(B)1. Nonpoint source pollutants are typically transported by stormwater runoff, which is minor or negligible during dry weather conditions. Although there are no specific *E. coli* data to indicate contributions from specific nonpoint sources, common nonpoint sources that have the potential to contribute bacteria loading to surface waters include agricultural lands, onsite wastewater treatment (septic) systems, and developed areas that do not have regulated storm sewer systems. Agricultural lands associated with land application of wastewater or sludge from permitted facilities, including CAFOs, are also considered nonpoint sources, so long as the activities meet agricultural practices and agronomic land application rates, without direct discharge from land application activities. Nonpoint source pollution can also result from natural background contributions, such as wildlife waste. Streams with little to no riparian buffer are most susceptible to nonpoint source pollution. The Department provides guidance and examples of BMPs to help reduce pollutant loading from nonpoint sources in the supplemental Cuivre River Nonpoint Source Implementation Strategies document at <https://dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls>. These actions are voluntary and not a requirement of this TMDL.

However, efforts to reduce pollutant loading from any potential nonpoint source contributor in the watershed is encouraged and will aid in meeting the water quality goals of this TMDL.

5.2.1 Agricultural Lands

Croplands, pasturelands, and low-density animal feeding operations are potential sources of bacteria in surface waters. Bacteria are transported in runoff from areas fertilized with animal manure, including poultry litter, and where livestock are present. Runoff can result from precipitation or excessive irrigation. Soil and Water Conservation Districts provide funding and guidance for the development of nutrient management plans for unregulated private lands. Areas where nutrient management plans guide manure application and where best management practices are used to reduce soil erosion contribute less bacteria to surface waters than unmanaged areas. Although grazing areas are typically well vegetated, livestock tend to congregate near feeding and watering areas, which can create barren areas that are susceptible to erosion (Sutton 1990). Additionally, livestock that are not excluded from streams will deposit manure, and thus bacteria, directly into the waterway.

As noted in Section 2.4 of this document, 20 percent of the Cuivre River watershed is pastureland. Aside from livestock present in permitted CAFOs, the exact type and number of livestock present in the Cuivre River and North Fork Cuivre River watersheds are unknown. There are no cattle CAFOs within the watershed. Therefore an estimate of the number of cattle in the watershed was calculated by using the available land cover data and county cattle population numbers provided in the U.S. Department of Agriculture’s 2017 Census of Agriculture (NASS 2017). Using the total number of cattle in the counties that contain that Cuivre River watershed and the proportion of each county’s area of pastureland in the watershed to the total area of pastureland in each county, it is estimated that there are 45,714 cows in the Cuivre River watershed (Table 14).²¹ In the North Fork Cuivre River watershed there are approximately 17,415 cattle. As previously noted, potential bacteria contributions from livestock vary depending upon individual land management practices and sites employing best management practices and exclude cattle from streams are expected to have less bacteria contributions.

Table 14. 2017 Cattle Population Estimates for Pasture Areas in the Cuivre River Watershed

County	Cattle No.	Pastureland (Sq. Mi.)	Pastureland in Watershed (Sq. Mi.)	Pastureland in Watershed/ Total Pastureland in County	Watershed Cattle No.
St. Charles	6,120	51.6	13.4	0.3	1,591
Warren	13,923	66.7	20.0	0.3	4,166
Montgomery	23,371	99.9	45.9	0.5	10,739
Lincoln	18,715	143.9	92.5	0.6	12,031
Audrain	28,961	125.8	17.6	0.1	4,040
Pike	34,983	155.2	58.3	0.4	13,147
Total Estimated Cattle in the Cuivre River Watershed					45,714

²¹ This analysis assumes all areas identified as grassland or pasture are being used for cattle grazing and that cattle are evenly distributed among those areas. Additionally, although some animals may be confined in some areas, for purposes of this estimation the entire cattle population was assumed to be grazing on pasture areas.

Other types of livestock such as horses and sheep may also be contributing bacteria loads in the Cuivre River and North Fork Cuivre River watersheds. However, the number and distribution of other animals in the watershed cannot be estimated from available data. Similar to cattle, areas employing best management practices to reduce erosion and contaminated runoff from entering surface waters are expected to have less bacteria contributions.

5.2.2 Runoff from Developed Areas

Developed areas where stormwater discharges are not regulated through MS4 permits are nonpoint sources of *E. coli* loading. In addition to the municipalities discussed in Section 5.1.4 as having MS4 permits, there are also eight other municipalities that may contribute urban runoff to surface waters. Sources of *E. coli* loading within these developed areas are similar to those previously described for areas with permitted MS4s.

As presented in Section 2.4, developed areas cover seven percent of the Cuivre River watershed and less than five percent of the North Fork Cuivre River watershed. Degradation of water quality associated with imperviousness has been shown to first occur in a watershed at about 10 percent total imperviousness and to increase in severity as imperviousness increases (Arnold and Gibbons 1996; Schueler 1994). A review of available aerial imagery does show areas of residential housing upstream of where high concentrations of bacteria loading have been observed. For this reason, unregulated stormwater runoff from these developed areas is a potential source of *E. coli* loading to the impaired water bodies. Residential land owners and municipalities not currently regulated by MS4 permits should consider best management practices and low impact development to mitigate potential pollutant loading.

5.2.3 Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems treat and disperse domestic wastewater on the property where it is generated. When properly designed and maintained, these systems perform well and should not contribute *E. coli* to surface waters. However, when these systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface water quality (Horsley and Witten 1996). Nondischarging systems of domestic wastewater having flows of 3,000 gallons per day or less may operate under a permit exemption as described in 10 CSR 20-6.010(1)(B)(11) and 10 CSR 20-6.015(3)(B)(6). The Missouri Department of Health and Senior Services or local administrative authorities (commonly the local health department) have jurisdiction over onsite wastewater treatment systems with a design or actual flow of 3,000 gallons per day or less. Municipalities or counties may impose more stringent or additional requirements for owners of onsite systems. The Missouri Department of Health and Senior Services estimates that approximately 25 percent of homes in Missouri use onsite wastewater treatment systems, particularly in rural areas where public sewer systems are not available (DHSS 2018). Failing onsite wastewater treatment systems can contribute *E. coli* to nearby streams under wet or dry weather conditions directly or through surface runoff and groundwater flows. Factors that may contribute to onsite wastewater treatment system failure include age, inadequate land area, poor soil drainage, high water table and inadequate maintenance. Proper maintenance of onsite wastewater treatment systems including septic tanks, associated drain fields, and household lagoons should minimize bacteria loading to surface waters.

The exact number of onsite wastewater treatment systems in the Cuivre River watershed is unknown. EPA's online input data server for the Spreadsheet Tool for Estimating Pollutant Load (STEPL) provides estimates of septic system numbers by 12-digit HUC watersheds based on 1992

and 1998 data from the National Environmental Service Center (USEPA 2014b).²² These STEPL derived estimates of septic system numbers are provided in Table 15.

Table 15 also provides statewide estimated failure rates from a study by the Electric Power Research Institute (EPRI 2000). The study suggests that in parts of Missouri, up to 50 percent of onsite wastewater treatment systems may be failing. Due to these high failure rates, onsite wastewater treatment systems are potential sources of bacteria loading to surface waters in Missouri. Due to the increase in population in rural areas of the watershed, the number of septic systems in the watershed has likely also increased in areas not serviced by a sanitary sewer system. However, newer systems are less likely to be failing than older systems, which may have been installed prior to current design standards and drain field specifications (MU Extension 2023). Inspections are required for all new onsite wastewater treatment systems installed in Lincoln County, and all installations and major repairs require permits issued by the Lincoln County Health Department (LCHD 2023). Lincoln County also has specific ordinances describing construction standards, maintenance schedules, setbacks, and penalties for noncompliance.

Table 15. STEPL Derived Estimates of Septic System Numbers

Watershed Name	No. of Systems	Total Population for Systems	Average Failure Rate (EPRI 2000)
Cuivre	11,268	69	30-50%
North Fork Cuivre River	1,955	16	

5.2.4 Natural Background Contributions

Wildlife such as deer, waterfowl, raccoons, rodents, and other animals contribute to the natural background concentrations of *E. coli* that may be found in a water body. Such contributions may be a component of runoff from agricultural areas, developed areas, forest lands, and other areas. While typical wildlife populations are not expected to cause or contribute to water body impairments, animals that congregate in large groups on or near water bodies may contribute significant bacteria to surface waters. For instance, Canada geese have been found to contribute significant bacteria loads in some waters (Ishii et al. 2007). There are no watershed-specific population data for waterfowl, but the Missouri Department of Conservation conducts statewide surveys in fall and winter. In 2020, waterfowl counts ranged from approximately 59,000 in October to 760,000 in late November (MDC 2021). The exact number of deer in the watershed is also not known, but the Missouri Department of Conservation keeps harvest records by county for each hunting season. Harvest data provides a general idea of the amount of deer that may be present in an area. Table 16 lists harvest data in the 2021-2022 season by county (MDC 2022). Background concentrations of bacteria may also be present in benthic sediments and, if disturbed, can be resuspended as bacteria lives longer in sediment than in water (Davis and Barr 2006; Marino and Gannon 1991). The significance of any resuspended bacteria to the impairment in Cuivre River watershed is unknown. Natural background contributions are included in the nonpoint source load allocations.

²² The National Environmental Services Center is located at West Virginia University and maintains a clearinghouse for information related to, among other things, onsite wastewater treatment systems. Available URL: www.nesc.wvu.edu/

Table 16. 2022 Deer Harvest

County	Harvest Counts
Pike	3,221
Lincoln	2,966
St. Charles	1,326
Warren	2,081
Montgomery	2,782
Audrain	1,732
Total	14,108

5.2.5 Riparian Corridor Conditions

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the attenuation of pollutants in runoff. Land cover within 100 feet of streams in the Cuivre River and North Fork Cuivre River watersheds are presented in Tables 17 and 18. Agricultural areas constitute around 30 percent of the riparian corridors of streams in the Cuivre River watershed and North Fork Cuivre River watershed. These areas may be more susceptible to *E. coli* loading. Over 54 percent of the riparian corridors in the Cuivre River watershed are forested and around 59 percent of the riparian corridors in North Fork Cuivre River watershed are forested. This indicates that some *E. coli* transported from adjacent cropland and pasture lands into those areas may be intercepted before it enters the streams.

Table 17. Land Cover in Riparian Corridors in the Cuivre River Watershed

Land Cover Type	Area Square Miles	Percent
Developed, High Intensity	0.05	0.07%
Developed, Medium Intensity	0.27	0.34%
Developed, Low Intensity	0.92	1.15%
Developed, Open Space	1.52	1.91%
Barren Land	0.13	0.16%
Cultivated Crops	12.76	16.01%
Hay/Pasture	10.23	12.84%
Shrub and Herbaceous	0.47	0.59%
Forest	43.44	54.51%
Wetlands	8.10	10.17%
Open Water	1.80	2.26%
Total	79.70	100.00%

Table 18. Land Cover in Riparian Corridors in the North Fork Watershed

Land Cover Type	Square Miles	Percent
Developed, High Intensity	0.01	0.03%
Developed, Medium Intensity	0.06	0.25%
Developed, Low Intensity	0.22	0.92%
Developed, Open Space	0.37	1.55%
Barren Land	0.02	0.10%
Cultivated Crops	3.11	12.99%
Hay/Pasture	4.09	17.07%
Shrub and Herbaceous	0.12	0.52%
Forest	14.07	58.71%
Wetlands	1.75	7.32%
Open Water	0.13	0.55%
Total	23.97	100.00%

6. Calculating Loading Capacity

A TMDL is equal to the loading capacity of a water body for a specific pollutant, which is the maximum pollutant load that a water body can assimilate and still attain and maintain water quality standards. The loading capacity is derived from the numeric water quality criterion for each pollutant or an appropriate surrogate when no numeric criterion is applicable. Once the maximum allowable pollutant load is determined, a portion is assigned to point sources as a wasteload allocation and to nonpoint sources as a load allocation. These allocations become the pollutant loading targets to restore water quality. A margin of safety is included to account for uncertainties in scientific and technical understanding of water quality in natural systems and to ensure water quality standards are achieved after all wasteload and load allocations are met.²³ The loading capacity is equal to the sum of the wasteload allocation, load allocation, and the margin of safety as follows:

$$\text{TMDL} = \text{LC} = \sum \text{WLA} + \sum \text{LA} + \text{MOS}$$

where LC is the loading capacity, $\sum \text{WLA}$ is the sum of the wasteload allocations, $\sum \text{LA}$ is the sum of the load allocations, and MOS is the margin of safety.

7. Total Maximum Daily Loads

According to 40 CFR 130.2(i), TMDLs can be expressed in terms of mass per unit time, toxicity, or other appropriate measures. The TMDLs for Cuivre River and North Fork Cuivre River are expressed as *E. coli* cfu per day using load duration curves developed using the applicable *E. coli* criterion concentration target of 126 cfu/100mL, all possible stream flows, and a unit conversion factor.²⁴ Establishing TMDLs using load duration curves is consistent with the Anacostia Ruling

²³ CWA Section 303(d)(1)(C) and 40 CFR 130.7(c)(1) require TMDLs to incorporate a margin of safety.

²⁴ $\text{Load} \left(\frac{\text{count}}{\text{time}} \right) = \text{Concentration} \left(\frac{\text{count}}{\text{volume}} \right) * \text{Flow} \left(\frac{\text{volume}}{\text{time}} \right) * \text{conversion factor} (24,465,715)$

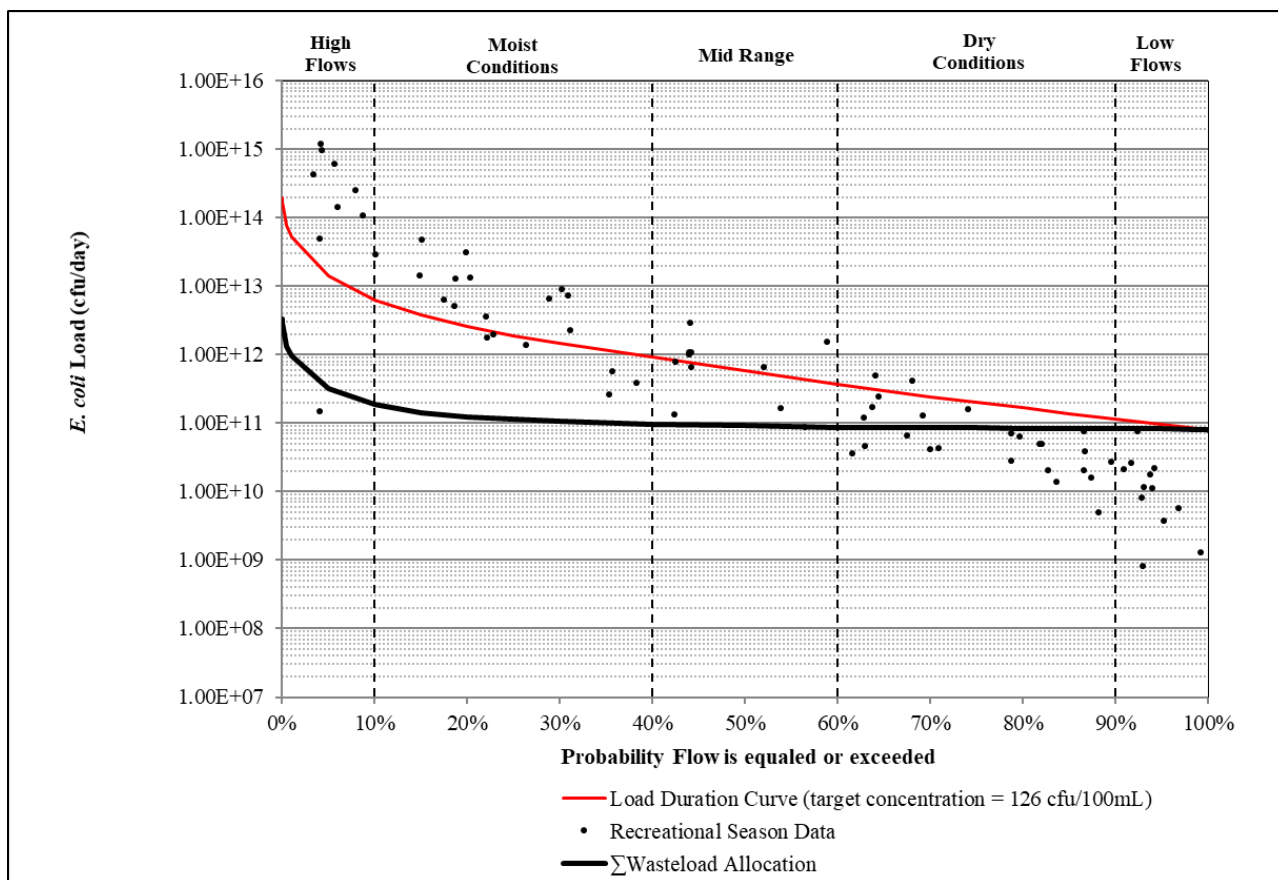
(*Friends of the Earth, Inc., et al v. EPA*, No 05-5010, April 25, 2006) and EPA guidance in response to that ruling (USEPA 2006; USEPA 2007a).

The selected TMDL target is protective of whole body and secondary contact recreational uses. The resulting load duration curves provide a visual representation of the pollutant loading capacity of the water bodies at all stream flows. The TMDLs are applicable during the recreational season (April to October) when the *E. coli* criterion applies. Using this approach the available loading capacity of the stream varies with flow, but the pollutant concentration remains constant. Although TMDLs are expressed as daily mass loads, *E. coli* criteria are expressed as geometric mean concentrations. Therefore, fluctuations in instantaneous concentrations are expected and individual bacteria measurements greater than the applicable criterion do not necessarily indicate a violation of water quality standards. Additional discussion about the methods used to develop the load duration curves for Cuivre River and North Fork Cuivre River are provided in Appendix C.

Observed data are plotted on the load duration curve graphs to demonstrate the magnitude of load reductions that are needed to meet the TMDLs and attain water quality standards. Points above the curve exceed the loading capacity and points on or below the curve are in compliance with water quality standards. The load duration curves also help to identify and differentiate between storm-driven loading and the presence of continuous loading. Storm-driven loading is expected under wet conditions when precipitation and runoff are high. Continuous loading is evident at low flows when point source discharges have greater influence on water quality. Load reductions needed to meet the *E. coli* criterion can be calculated using the geometric means of observed data within each flow percentile range and are provided in the supplemental Nonpoint Source Implementation Strategies document located at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

The *E. coli* load duration curves for Cuivre River and North Fork Cuivre River are displayed in Figures 10 and 11. The y-axes quantify the *E. coli* mass load in cfu per day at the flow conditions (percentage of time flow is equaled or exceeded) on the x-axes. Lower flows are equaled or exceeded more frequently than higher flows (i.e., greater than 90 percent of the time). The flow ranges are consistent with EPA guidance for using load duration curves to develop TMDLs (USEPA 2007b).

The TMDLs and associated allocations at selected percentile flow exceedances are displayed in Tables 19 and 20. Due to the extremely large numbers associated with bacteria loads, *E. coli* values are presented using scientific notation. Specific allocations for individual sources are discussed in Sections 8 and 9.

Figure 10. *E. coli* TMDL for Cuivre River (WBID 152)Table 19. *E. coli* TMDL and Allocations for the Cuivre River at Selected Flows

Percent of Time Flow is Equaled or Exceeded	Flow (cfs)	TMDL (cfu/day)	ΣWLA (cfu/day)	ΣLA (cfu/day)	MOS (cfu/day)
95	31.29	9.64E+10	8.32E+10	3.62E+09	9.64E+09
75	66.14	2.04E+11	8.49E+10	9.86E+10	2.04E+10
50	190.39	5.87E+11	9.12E+10	4.37E+11	5.87E+10
25	616.92	1.90E+12	1.13E+11	1.60E+12	1.90E+11
5	4,672.88	1.44E+13	3.18E+11	1.26E+13	1.44E+12

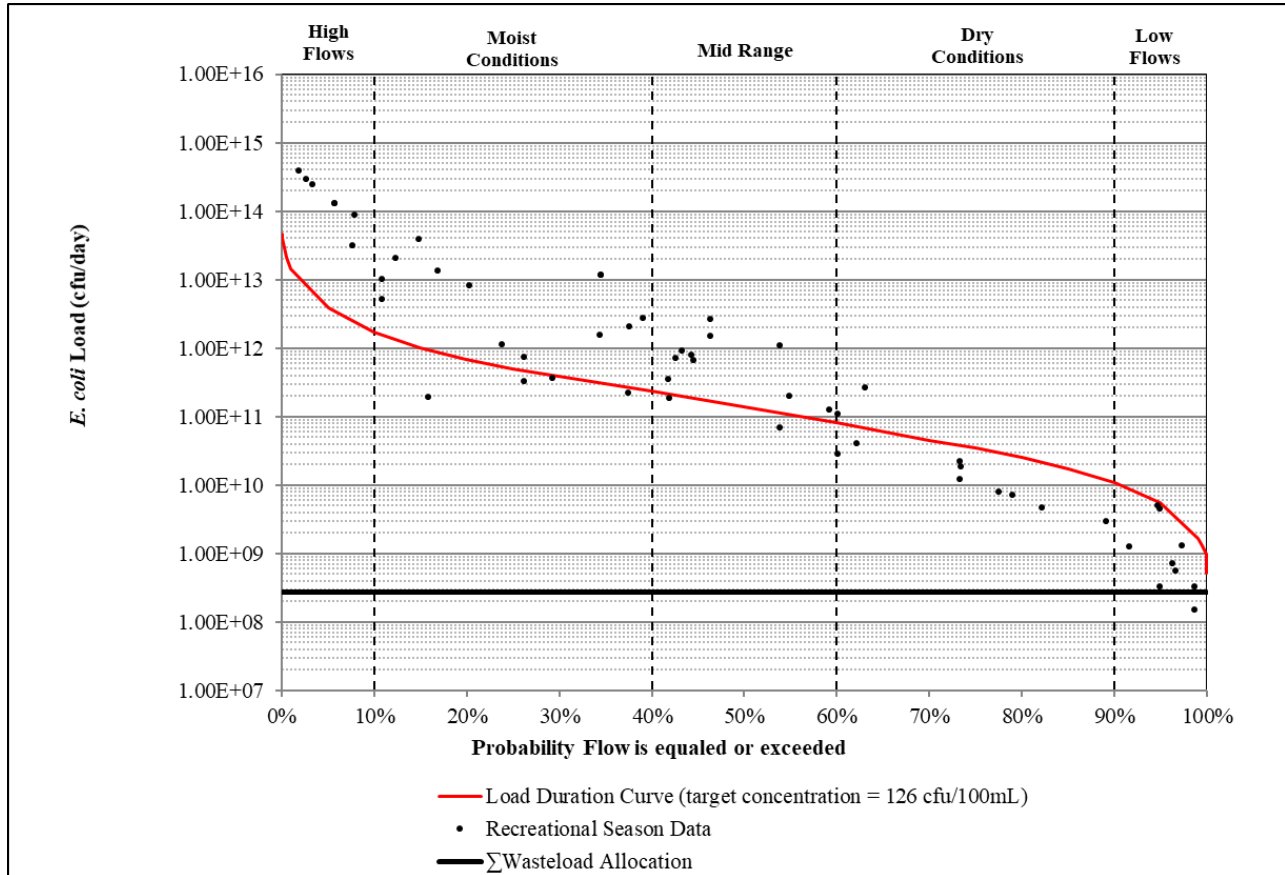


Figure 11. *E. coli* TMDL for North Fork Cuivre River (WBID 158)

Table 20. *E. coli* TMDL and Allocations for North Fork Cuivre River at Selected Flows

Percent of Time Flow is Equaled or Exceeded	Flow (cfs)	TMDL (cfu/day)	Σ WLA (cfu/day)	Σ LA (cfu/day)	MOS (cfu/day)
95	1.77	$5.46E+09$	$2.70E+08$	$4.65E+09$	$5.46E+08$
75	11.31	$3.49E+10$	$2.70E+08$	$3.11E+10$	$3.49E+09$
50	45.33	$1.40E+11$	$2.70E+08$	$1.25E+11$	$1.40E+10$
25	162.09	$5.00E+11$	$2.70E+08$	$4.49E+11$	$5.00E+10$
5	1,272.46	$3.92E+12$	$2.70E+08$	$3.53E+12$	$3.92E+11$

8. Wasteload Allocation (Point Source Load)

The wasteload allocation is the portion of the loading capacity assigned to existing or future point sources. Pursuant to 40 CFR 122.44(d)(1)(vii)(B), effluent limits or other permit conditions must be consistent with the assumptions and requirements of TMDL wasteload allocations. The wasteload allocations presented in this TMDL report do not preclude the establishment of future point sources. Any future point sources should be evaluated against the TMDL, the range of flows with which any additional bacterial loading will affect, and any additional requirements associated with antidegradation. Federal regulation 40 CFR 122.4(a) disallows the issuance of a National Pollutant Discharge Elimination System (NPDES) permit if the conditions of the permit cannot provide for compliance with the applicable requirements of the federal Clean Water Act, or regulations promulgated under the federal Clean Water Act. Additionally, 40 CFR 122.4(i) states no permit may

be issued to a new source or new discharger if the discharge from its construction or operation will cause or contribute to a violation of water quality standards. After undergoing antidegradation review, any new facility that discharges wastewater containing *E. coli* will be required to disinfect its effluent during the recreational season or use other approaches (e.g., no discharge or batch discharges) that will result in negligible bacteria loading during the recreational season. Such negligible loading is not expected to result in loading that will exceed the sum of the total wasteload allocation. Decommissioning of onsite wastewater treatment systems and connecting to a sewerage system for wastewater treatment will result in net pollutant reductions that are consistent with the goals of this TMDL. Due to localized health concerns associated with bacteria and whole body contact recreation, water quality trading cannot be used as a mechanism for complying with the wasteload allocations established in this TMDL.

8.1 Domestic Wastewater Treatment Facilities

The wasteload allocations for domestic wastewater dischargers in the Cuivre River watershed are presented in Table 21 for Cuivre River and Table 22 for North Fork Cuivre River watershed. These allocations are based on individual facility design flows and the applicable *E. coli* criterion to protect recreational uses in the receiving waters of the effluent discharges. For the Cuivre River, at low flow conditions greater than the 95th percent flow exceedance the total wasteload allocation is equal to the loading capacity. All discharging domestic WWTFs in the watershed either currently have *E. coli* effluent limits or a schedule of compliance to meet these limits. Most facilities have disinfection technologies in operation at these facilities which reduce *E. coli* well below the limit. This provides the required margin of safety during these periods. It should also be noted that stormwater discharges from MS4s and nonpoint source areas are not expected to occur during these extreme low flow conditions. Additional margins of safety are discussed in Section 10.

Tables 21 and 22 provide individual facility wasteload allocations to Cuivre River. Permitted facilities within the North Fork Cuivre River watershed are also within the Cuivre River watershed. Although wasteload allocations are presented for each water body, these wasteload allocations are equivalent to each other and are not additive. Actual flows that are less than the design flows may result in bacteria loads less than the calculated wasteload allocations. The wasteload allocations in this TMDL report do not authorize any facility to discharge bacteria at concentrations that exceed water quality standards, but may accommodate additional facility loading due to population increases or expansions in service area. The wasteload allocations in this TMDL report are applicable at all flows during the recreational season and do not include loading that may result from sanitary sewer overflows. For facilities within two miles of a losing stream segment, the wasteload allocation applies at all flows year round and not just during the recreational season. Facilities operating under permits that do not authorize a discharge (no discharge) are assigned an allocation of zero at all flows. Sanitary sewer overflows are unpermitted discharges and are not authorized under the Clean Water Act. For this reason, sanitary sewer overflows in the Cuivre River watershed and North Fork Cuivre River watershed are assigned wasteload allocations of zero at all flows.

Table 21. WLAs for Domestic Discharges in the Cuivre River Watershed

Permit No.	Facility Name	Design Flow (gal/day)	<i>E.coli</i> Target (cfu/100 mL)	WLA (cfu/day)
MO0040851	Jonesburg WWTF	120,000	126	5.72E+08
MO0045497	GSA Camp Tuckaho WWTP	15,000	126	7.15E+07

Permit No.	Facility Name	Design Flow (gal/day)	<i>E.coli</i> Target (cfu/100 mL)	WLA (cfu/day)
MO0050695	Wellsville East WWTF	158,000	126	7.54E+08
MO0054623	Troy Hwy 47 WWTP	1,300,000	126	6.20E+09
MO0055387	Middletown City WWTF	8,220	126	3.92E+07
MO0081574	Jonesburg Gardens WWTF	18,800	126	8.97E+07
MO0084158	Montgomery City East WWTP	500,000	126	2.38E+09
MO0087211	Roy L. Utilities WWTF	19,000	126	9.06E+07
MO0087912	Warrenton WWTP	3,200,000	126	1.53E+10
MO0093599	Wentzville Water Reclamation Center	5,340,000	126	2.55E+10
MO0098060	Fabick Foristell WWTP	9,000	126	4.29E+07
MO0098817	MAWC Incline Village WWTF No. 1	80,000	126	3.82E+08
MO0099228	LCPWSD No. 1 Green Acres WWTF	55,800	126	2.66E+08
MO0100358	MAWC Warren-Lincoln County No. 2 WWTP	80,000	126	3.82E+08
MO0103021	Village of Benton City WWTF	20,000	126	9.54E+07
MO0103764	Bellflower WWTF	60,000	126	2.86E+08
MO0108243	Silex WWTF	22,696	126	1.08E+08
MO0108715	Anchor House of Warren County WWTF	3,650	126	1.74E+07
MO0109495	Orchard Farm Park WWTP	11,900	126	5.68E+07
MO0109673	North Oak Sewer District WWTP	50,000	126	2.38E+08
MO0110680	Pleasant Oak MHP WWTP	19,000	126	9.06E+07
MO0112542	Big Creek Estates WWTP	15,900	126	7.58E+07
MO0113042	Shannon's Little River Farm	3,000	126	1.43E+07
MO0113387	Country Horizon MHP WWTP	3,300	126	1.57E+07
MO0113786	16200 Veterans Memorial East WWTF	3,000	126	1.43E+07
MO0116106	Lindemann MHP WWTF	5,000	126	2.38E+07
MO0116262	Lindemann Hometown Court WWTF	25,200	126	1.20E+08
MO0116343	Deer Run Meadows WWTP	5,200	126	2.48E+07
MO0117269	Country Cove MHP WWTF	18,700	126	8.92E+07
MO0118087	Oakwood Mobile Home Park	1,100	126	5.25E+06
MO0118192	Truxton WWTF	12,000	126	5.72E+07
MO0119385	Charwood Estates WWTP	9,990	126	4.76E+07
MO0119709	Moscow Mills - NW Area WWTF	999,990	126	4.77E+09
MO0122378	Red Hawk Estates MHP WWTF	62,000	126	2.96E+08
MO0122971	Bennington WWTP	24,000	126	1.14E+08
MO0125172	Prairie Meadow Subdivision WWTF	2,800	126	1.34E+07
MO0125644	Hickory Farms Subdivision WWTF	4,800	126	2.29E+07
MO0126381	Quail Run MHP WWTF	130,000	126	6.20E+08
MO0128171	Glenmeadows WWTF	80,000	126	3.82E+08
MO0128775	Norton Woods Sewage Treatment	55,300	126	2.64E+08
MO0128872	North Troy Business Park WWTP	5,400	126	2.58E+07

Permit No.	Facility Name	Design Flow (gal/day)	<i>E.coli</i> Target (cfu/100 mL)	WLA (cfu/day)
MO0129356	Auburn Lake WWTP	90,280	126	4.31E+08
MO0129721	Faith Christian Family Church WWTF	5,500	126	2.62E+07
MO0129852	Moscow Mills Crooked Creek WWTP	1,200,000	126	5.72E+09
MO0129984	Lazy Acres Subdivision WWTP	10,000	126	4.77E+07
MO0130125	Majestic Lakes WWTP	79,000	126	3.77E+08
MO0131211	MAWC Anna Meadows Subdivision WWTP	62,500	126	2.98E+08
MO0131261	Elm Tree Estates HOA WWTP	37,000	126	1.76E+08
MO0131296	Troy Southeast WWTP	1,870,000	126	8.92E+09
MO0132047	North Moore Estates WWTF	9,750	126	4.65E+07
MO0132373	MAWC Jaxson Estates WWTP	150,000	126	7.15E+08
MO0132497	Rockport Subdivision WWTP	78,000	126	3.72E+08
MO0133264	SCCPWSD#2 Providence Estates WWTP	250,000	126	1.19E+09
MO0134180	Pear Tree Property WWTP	4,200	126	2.00E+07
MO0134309	Keystone Estates WWTP	13,700	126	6.53E+07
MO0135551	Renae Aldein WWTP	4,000	126	1.91E+07
MO0136204	SCCPWSD 2 Hickory Trails WWTP	600,000	126	2.86E+09
MO0138312	Oakwind Estates WWTP	25,000	126	1.19E+08
MOGD00362	Cedar Ridge Estates WWTP	3,500	126	1.67E+07
MOGD00407	Westborough Estates WWTP	28,000	126	1.34E+08
MO0107816	Flying J No. 674 WWTP	24,000	126	1.14E+08
MOGD00456	L and L Mobile Home Park WWTF	5,000	126	2.38E+07
MOG823118	Aviary Recovery Center	No Discharge	-	0
MO0055409	Farber WWTF	No Discharge	-	0
MO0028053	Hawk Point WWTF	No Discharge	-	0
MOG823091	Big Larrys Campground WWTF	No Discharge	-	0
MO0112470	Eolia WWTF	No Discharge	-	0
MO0136441	Community R-VI School WWTF	No Discharge	-	0
Total				8.16E+10

Table 22. WLAs for Domestic Discharges in the North Fork Cuivre River Watershed

Permit No.	Facility Name	Design Flow (gal/day)	<i>E.coli</i> Target (cfu/100 mL)	WLA (cfu/day)
MO0108243	Silex WWTF	22,696	126	1.08E+08
MO0119385	Charwood Estates WWTP	9,990	126	4.76E+07
MO0128872	North Troy Business Park WWTP	5,400	126	2.58E+07

MO0129984	Lazy Acres Subdivision WWTP	10,000	126	4.77E+07
MOGD00362	Cedar Ridge Estates WWTP	3,500	126	1.67E+07
MOGD00456	L and L Mobile Home Park WWTF	5,000	126	2.38E+07
MOG823118	Aviary Recovery Center	No discharge	-	0
MOG823091	Big Larrys Campground WWTF	No discharge	-	0
MO0112470	Eolia WWTF	No discharge	-	0
Total				2.70E+08

8.2 Industrial and Commercial Facilities

There are two site-specific permitted industrial or commercial facilities in the Cuivre River – Harbison-Walker Refractories Vandalia Place (MO0000710) and Stone Ridge Canyon (MO0128121). When all permit limits and conditions are met, these facilities are not expected to cause or contribute to the *E. coli* impairment of Cuivre River or North Fork Cuivre River. For this reason, wasteload allocations for these site-specific facilities are set at existing permit limits and conditions, which is expected to result in negligible *E. coli* loading and will not exceed the sum of the total wasteload allocation. There are also twelve general permitted industrial and commercial facilities that do not allow discharge (Table 10). Because these facilities are prohibited from discharging to surface waters, the wasteload allocation for these facilities is zero at all flows. Wasteload allocations for other general permitted facilities are discussed in Section 8.5.

8.3 Concentrated Animal Feeding Operations

All CAFO facilities in the Cuivre River and North Fork Cuivre River Watersheds are subject to permits that do not allow discharge directly or during land application. For this reason, the *E. coli* wasteload allocation for CAFO facilities is zero at all flows.

8.4 Municipal Separate Storm Sewer Systems

Wasteload allocations for MS4 discharges are based on the proportion of the U.S. Census Bureau's defined urban area in the Cuivre River watershed. The City of Troy is not in a defined urban area and instead was calculated using the municipal boundary. This area was added to the defined urban area within the Cuivre River watershed. Bacterial contributions from MS4 permitted entities are precipitation dependent and vary with flow. For this reason, wasteload allocated to the MS4s will also vary with flow. During low flow conditions MS4s are not expected to discharge in response to precipitation. At extreme low flow conditions (i.e., > 95 percent flow exceedance), the wasteload allocation is zero. Due to data limitations and the complex and diffuse nature of stormwater runoff, specific MS4 wasteload allocations cannot be adequately determined. For this reason, the MS4 wasteload allocations are aggregated for all MS4s. Should the U.S. Census Bureau's defined urban area in the watershed be expanded in the future, then the appropriate portion of the load allocation may be assigned as part of the MS4 wasteload allocation if such a source's magnitude, character, and location remain unchanged. Due to the relatively small proportion of the watershed contributing stormwater flow to areas having a regulated MS4 (< 2 percent), MS4s are not expected to be a significant contributor of *E. coli* loading to Cuivre River. For this reason, existing MS4 permit conditions and continued implementation of BMPs and the six minimum control measures are expected to be consistent with the assumptions and requirements of the MS4 wasteload allocation. However, future bacteria monitoring may provide more specific information regarding each MS4 area's actual contributions, including specific sources and mechanisms of transport, thereby

allowing permit conditions to be modified accordingly if needed. Table 23 displays the aggregated MS4 wasteload allocation at selected flows.

Table 23. Aggregated MS4 Wasteload Allocation

Percent of time flow is equaled or exceeded	Flow ft ³ /s	<i>E. coli</i> (cfu/day)
95	31.29	1.58E+09
75	66.14	3.35E+09
50	190.39	9.64E+09
25	616.92	3.12E+10
5	4,672.88	2.37E+11

8.5 Other General Permitted Wastewater and Stormwater Discharges

There are no other general or stormwater permitted facilities in the Cuivre River watershed that are expected to contribute *E. coli* concentrations above negligible amounts to surface waters. Permit conditions for these activities are protective of the designated uses assigned to all water bodies in the watersheds. Activities for which these permits are issued are expected to be conducted in compliance with all permit conditions, including any land application, monitoring, stormwater pollution prevention plans, and discharge limitations. For these reasons, the *E. coli* wasteload allocations for these facilities are set at existing permit limits and conditions. Future general and stormwater permitted activities that do not actively generate bacteria and that operate in full compliance with permit conditions are not expected to contribute bacteria loads above negligible levels and will not result in loading that exceeds the sum of the TMDL wasteload allocations.

8.6 Illicit Straight Pipe Discharges

Illicit straight pipe discharges are illegal and are not permitted under the federal Clean Water Act. For this reason, illicit straight pipe discharges are assigned *E. coli* wasteload allocations of zero. Any existing illicit straight pipe discharges must be eliminated and future discharges of this type should be prevented.

9. Load Allocation (Nonpoint Source Load)

The load allocation is the portion of the loading capacity assigned to existing and future nonpoint sources and natural background contributions (40 CFR 130.2(g)). The load allocation for the Cuivre River and North Fork Cuivre River TMDL is calculated as the remainder of the loading capacity after allocations to the wasteload allocation and the margin of safety. The load allocations include contributions from agricultural lands, runoff from developed areas, and natural background contributions. No portion of the load allocations is assigned to onsite wastewater treatment systems because when they are properly maintained and operating as designed they do not discharge *E. coli* directly to surface waters.

10. Margin of Safety

A margin of safety is required to account for uncertainties in scientific and technical understanding of water quality in natural systems (CWA Section 303(d)(1)(C) and 40 CFR 130.7(c)(1)). Based on EPA guidance, the margin of safety can be achieved through two approaches:

- Explicit - Reserve a portion of the loading capacity as a separate term in the TMDL.

- Implicit - Incorporate the margin of safety within the wasteload allocation and the load allocation calculations by making conservative assumptions in the analysis.

For the Cuivre River TMDL, only implicit margins of safety are applied at very low flows greater than the 95 percent flow exceedance. During all other flow conditions, an explicit margin of safety equal to 10 percent of the loading capacity is also applied. For the North Fork Cuivre River TMDL, an explicit margin of safety (10 percent) is applied at all flows.

Bacteria decay rates were not applied and the direct recreational-season geometric mean criterion concentration was used for estimating the daily loading value required by the federal Clean Water Act. These conservative assumptions serve as additional implicit margins of safety. Additionally, domestic wastewater treatment facilities employing disinfection technologies operate to eliminate nearly all present pathogens (target = 0 cfu/100mL) rather than targeting a specific water quality criterion. This results in *E. coli* concentrations much lower than stated wasteload allocations.

11. Monitoring Plans

The Department conducts water quality monitoring in impaired waters within a reasonable timeframe following the approval of TMDLs, completion of facility upgrades and permit compliance schedules, or the implementation of watershed best management practices. The Department will also routinely examine any available quality-assured water quality data collected by other local, state, and federal entities in order to assess the effectiveness of TMDL implementation. In addition, certain quality-assured data collected by universities, municipalities, private companies, and volunteer groups may be used to assess water quality following TMDL implementation.

12. Seasonal Variation

Federal regulations at 40 CFR 130.7(c)(1) require that TMDLs take into consideration seasonal variation in applicable water quality standards. The load duration curves provide the *E. coli* loading capacities for each water body at all possible flow regimes using data collected during all seasons. The *E. coli* TMDLs are therefore protective of designated uses during critical conditions throughout the recreational season, including during high flows associated with intense rainfall events when bacteria loading is more likely.

13. Reasonable Assurance

Section 303(d)(1)(C) of the federal Clean Water Act requires that TMDLs be established at a level necessary to implement applicable water quality standards. As part of the TMDL process, consideration must be given to the assurances that point and nonpoint source allocations will be achieved and water quality standards attained. Where TMDLs are developed for waters impaired by point sources only, reasonable assurance is provided through NPDES permitting program. State operating permits requiring effluent and instream monitoring be reported to the Department provide reasonable assurance that instream water quality standards will be met.

Where a TMDL is developed for waters impaired by both point and nonpoint sources, point source wasteload allocations must be stringent enough so that in conjunction with the water body's other loadings (i.e., nonpoint sources) water quality standards are met. Reasonable assurance that nonpoint sources will meet their allocated amount is dependent upon the availability and implementation of nonpoint source pollutant reduction plans, controls, or best management practices

within the watershed. If best management practices or other nonpoint source pollution controls allow for more stringent load allocations, then wasteload allocations can be less stringent. Thus, the TMDL process provides for nonpoint source control tradeoffs (40 CFR 130.2(i)). When a demonstration of nonpoint source reasonable assurance is developed for an impaired water body, additional pollutant allocations for point sources may be allowed provided water quality standards are still attained. If a demonstration of nonpoint source reasonable assurance does not exist, or it is determined that nonpoint source pollutant reduction plans, controls, or best management practices are not feasible, durable, or will not result in the required load reductions, then allocation of greater pollutant loading to point sources cannot occur.

A variety of grants and loans may be available to assist watershed stakeholders with developing and implementing watershed based plans, controls, and practices to meet the required wasteload and load allocations in the TMDL and demonstrate reasonable assurance. Information regarding potential funding sources, cost-share opportunities, and implementation actions that address nonpoint source loading in the Cuivre River and North Fork Cuivre River watersheds are provided in the supplemental TMDL Implementation Strategies document available online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls.

14. Public Participation

EPA regulations at 40 CFR 130.7 require that TMDLs be subject to public review. A 45-day public notice period for this TMDL report was held from April 28, 2023, through June 12, 2023. All public comments received during this public comment period were considered during the finalization of the TMDL. This TMDL was submitted to EPA on August 2, 2023. Due to needed modifications to the flow record and recalculation of the loading capacity following submission of the TMDL, the Department updated the TMDL and scheduled a second 45-day public notice period from October 13, 2023 through November 27, 2023. Groups that directly received notice of the public comment period for this TMDL include, but are not limited to:

- Missouri Clean Water Commission;
- Missouri Department of Conservation;
- County Soil and Water Conservation Districts;
- County health departments;
- County commissions;
- University of Missouri Extension;
- Missouri Coalition for the Environment;
- Missouri Farm Bureau;
- Stream Teams United;
- Stream Team volunteers living in or near the watershed; and
- Missouri state legislators representing areas within the watershed.

In addition to those groups directly contacted about the public notice, this TMDL report and a nonpoint source implementation strategies document are posted on the Department's TMDL webpage dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls. All comments received during the public comment periods and the Department's responses to those comments will also be made available at this location.

The Department maintains an email distribution list for notifying subscribers of significant TMDL updates or activities, including public notices and comment periods. Those interested in subscribing to TMDL updates can submit their email address using the online form available at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

15. Administrative Record and Supporting Documentation

The Department has an administrative record on file for the Cuivre River, North Fork Cuivre River *E. coli* TMDL. The record contains information on which the TMDL is based. It additionally includes the TMDL nonpoint source implementation strategies document, the public notice announcement, any public comments received, and the Department's responses to those comments. This information is available upon request to the Department at <https://dnr.mo.gov/open-records-sunshine-law-requests>. The Department will process any request for information about this TMDL in accordance with Missouri's Sunshine Law (Chapter 610, RSMo) and the Department's administrative policies and procedures governing Sunshine Law requests.

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Appendix A



Figure A-1. 12-digit HUCs within the Cuivre River watershed

Table A-1. 12-digit HUC subwatersheds in Cuivre River Watershed²⁵

12-digit HUCs	Subwatershed Name
071100080101	Headwaters West Fork Cuivre River
071100080102	Hickory Creek
071100080103	Johns Branch-West Fork Cuivre River
071100080104	Coon Creek
071100080105	Sandy Fork-West Fork Cuivre River
071100080201	Headwaters Indian Creek
071100080202	Cuivre Creek
071100080203	Indian Creek

²⁵ 12-digit HUCs are a common scale for watershed planning

12-digit HUCs	Subwatershed Name
071100080204	Lick Creek-North Fork Cuivre River
071100080205	Sandy Creek
071100080206	Sulphur Creek
071100080207	Mill Creek-North Fork Cuivre River
071100080208	North Fork Cuivre River
071100080301	Upper Elkhorn Creek
071100080302	Middle Elkhorn Creek
071100080303	Lower Elkhorn Creek
071100080304	Brush Creek
071100080305	Little Bear Creek-Bear Creek
071100080306	Bear Creek
071100080307	Camp Creek
071100080308	Bracht Branch-West Fork Cuivre River
071100080309	Lead Creek
071100080310	West Fork Cuivre River
071100080401	Sugar Creek
071100080402	Crooked Creek
071100080403	Spring Creek-Cuivre River
071100080404	Upper Big Creek
071100080405	Coon Creek
071100080406	Middle Big Creek
071100080407	Indian Camp Creek
071100080408	McCoy Creek
071100080409	Lower Big Creek
071100080410	Groshong Branch-Cuivre River
071100080411	Cuivre River

Appendix B

Cuivre River and North Fork Cuivre River (WBIDs 152 and 158) *E. coli* data collected by the Missouri Department of Natural Resources (MODNR) and the U.S. Geological Survey (USGS)

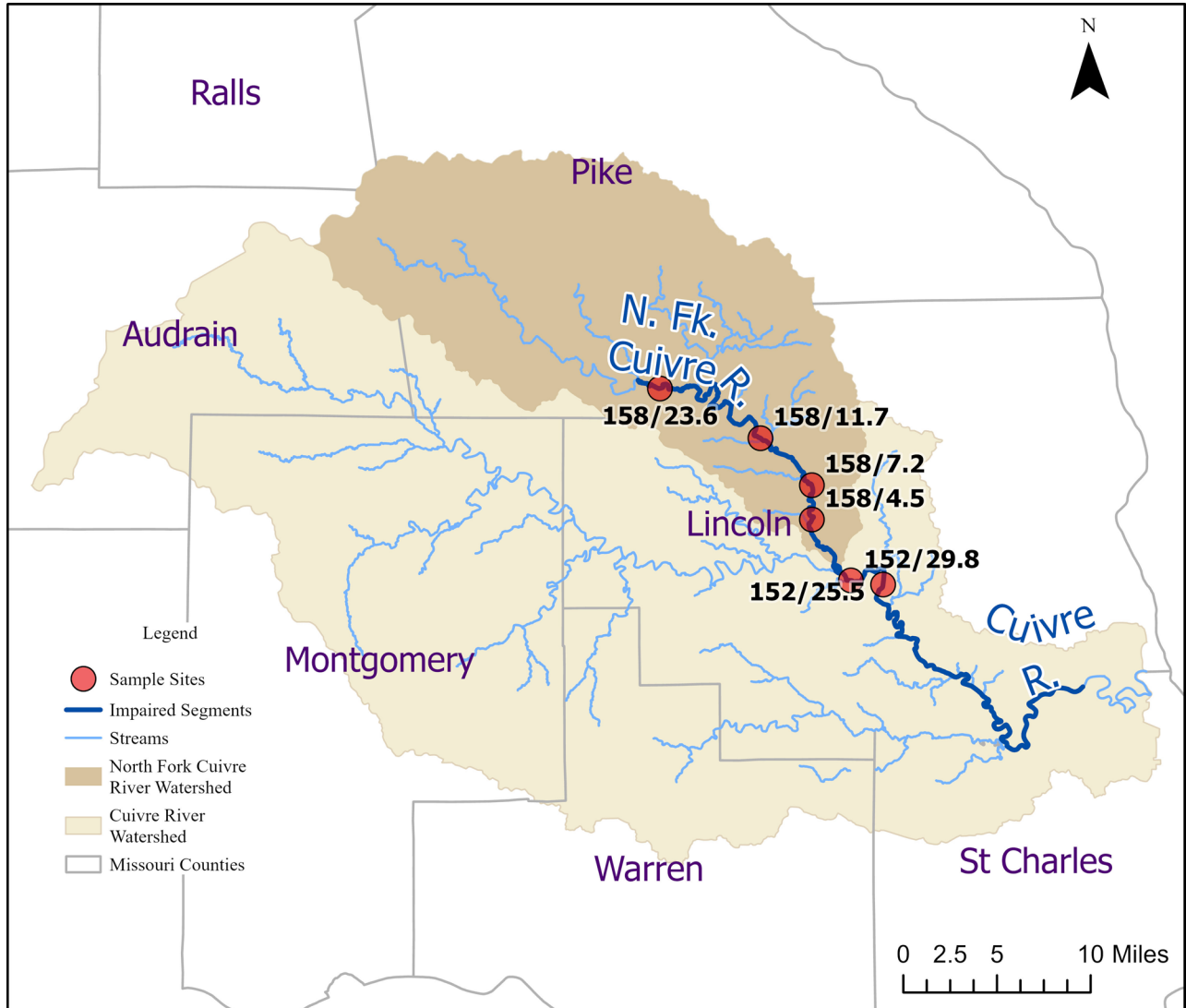


Figure B-1. Monitoring Site Locations in the Cuivre River and North Fork Cuivre River Watershed

Table B-1: Cuivre River and North Fork Cuivre River (WBIDs 152 and 158) *E. coli* data collected by the Missouri Department of Natural Resources (MODNR) and USGS

Water Body	Organization	Site Code	Site Name	Date	<i>E. coli</i> (#/100ml)	
152	MODNR	152/25.5	Cuivre River near Frenchman Bluff Rd.	9/11/2018	20.1	
				10/10/2018	4,839.2	
				10/30/2018	90.9	
		USGS	152/29.8	Cuivre River at Troy	7/13/2016	178.5
					7/13/2016	161.6
					9/29/2016	31.1
					5/9/2017	115.3
					7/6/2017	4,839.2
					8/1/2017	156.5
					8/31/2017	46.4
					8/16/2018	30.1
					8/29/2018	73.8
	5/19/1999				1,000.0	
	7/20/1999				17.0	
	9/8/1999				15.0	
	5/23/2000				2,100.0	
	7/11/2000				410.0	
	9/12/2000				66.0	
	5/15/2001				40.0	
	7/24/2001				280.0	
	9/5/2001				320.0	
	5/15/2002				680.0	
	7/10/2002				100.0	
	9/4/2002				50.0	
	5/20/2003				29.0	
	7/22/2003				96.0	
	9/3/2003				1,500.0	
	5/3/2004				230.0	
	7/20/2004				200.0	
	9/14/2004				40.0	
	5/3/2005				25.0	
	7/26/2005	22.0				
	9/7/2005	10.0				
	5/16/2006	18.0				
	7/20/2006	17.0				
	4/24/2007	20.0				
	5/21/2007	100.0				
	6/4/2007	480.0				
	7/9/2007	40.0				
	9/5/2007	2.0				
	5/22/2008	64.0				
	7/23/2008	6,200.0				
	9/3/2008	680.0				
	5/5/2009	200.0				

Water Body	Organization	Site Code	Site Name	Date	<i>E. coli</i> (#/100ml)
				7/29/2009	7100.0
				9/2/2009	490.0
				10/29/2009	330.0
				5/26/2010	100.0
				7/13/2010	800.0
				9/8/2010	46.0
				10/18/2010	22.0
				5/4/2011	48.0
				7/11/2011	110.0
				9/7/2011	1.0
				10/25/2011	14.0
				5/2/2012	8,500.0
				7/17/2012	5.0
				9/5/2012	28.0
				10/2/2012	8.0
				5/22/2013	1,800.0
				7/24/2013	65.0
				9/18/2013	38.0
				5/14/2014	3,800.0
				7/15/2014	650.0
				9/3/2014	3,200.0
				10/6/2014	260.0
				5/5/2015	42.0
				7/20/2015	1.0
				9/14/2015	200.0
				10/20/2015	20.0
				5/23/2016	180.0
				7/27/2016	530.0
				9/12/2016	590.0
				10/4/2016	23.0
				4/6/2017	4839.2
				5/24/2017	580.0
				7/18/2017	13.0
				9/13/2017	24.0
				10/11/2017	3,200.0
				5/22/2018	480.0
				7/11/2018	29.0
				9/11/2018	50.0
				10/2/2018	14.0
				5/8/2019	100.0
				7/24/2019	120.0
				8/20/2019	68.0
				9/17/2019	12.0
				10/2/2019	5.0
				8/3/2020	210.0
				10/14/2020	16.0
				2021-05-03	240.0

Water Body	Organization	Site Code	Site Name	Date	<i>E. coli</i> (#/100ml)
				2021-07-13	5,500.0
				2022-05-24	600
				2022-10-25	240
158	MODNR	158/4.5	North Fork Cuivre River at Davis Rd.	7/2/2012	17.3
				7/16/2012	7.4
				8/15/2012	21.3
				8/30/2012	9.8
				9/11/2012	101.9
				9/25/2012	51.2
				10/11/2012	17.1
				10/25/2012	33.2
				4/2/2013	25.9
				5/8/2013	410.6
				5/21/2013	4,839.2
				6/10/2013	1,986.3
				6/24/2013	980.4
				7/1/2013	435.2
				7/15/2013	231.0
				8/7/2013	61.3
				8/19/2013	27.2
				9/5/2013	30.9
				5/22/2014	206.4
				6/24/2014	1,986.3
				7/2/2014	547.5
				7/17/2014	4,839.2
				8/14/2014	488.4
				8/26/14	161.85
				9/24/2014	71.2
				9/10/2014	4,839.2
				10/24/2014	104.6
				10/29/2014	111.2
				4/9/2015	4,839.2
				4/20/2015	272.3
				5/5/2015	44.25
				5/20/2015	479.05
				6/1/2015	1,732.9
				7/22/2015	816.4
				9/10/2015	1,413.6
				4/13/2016	1,553.1
				5/12/2016	4,839.2
				6/28/2016	579.4
				7/7/2021	203.5
				8/11/2021	172.0
				9/15/2021	74.3
				10/5/2021	4,839.2
				10/19/2021	1,986.3
				4/18/2022	4,839.2

Water Body	Organization	Site Code	Site Name	Date	<i>E. coli</i> (#/100ml)
		158/23.6	North Fork Cuivre River at Kelch Rd	7/8/2021	114.5
				8/12/2021	190.4
				9/20/2021	33.6
				10/4/2021	4,839.2
				10/20/2021	1,203.3
				4/19/2022	4,839.2
		158/7.2	North Fork Cuivre River at Mackville Road	10/10/2013	108.1
				10/30/2013	20.3
				4/22/2014	75.9
				5/6/2014	461.1
				6/9/2014	648.8
		158/11.7	North Fork Cuivre River near Silex	7/7/2021	88.4
				8/11/2021	44.3
				9/15/2021	40.8
				10/5/2021	4,839.2
				10/19/2021	1,119.9
				4/18/2022	4,839.2

Appendix C

Development of *E. coli* Load Duration Curves

Overview

Load duration curves were used to develop the *E. coli* TMDLs for the Cuivre River and North Fork Cuivre River. Load duration curves visually display the loading capacity of a water body at all possible flows based on historic flow data and the defined target concentration for each pollutant. For this TMDL, a portion of the *E. coli* loading capacity is assigned to a wasteload allocation based on the individual design flows of domestic wastewater treatment facilities present in the watershed, as well as allocations to MS4s based on the proportion of the watershed potentially contributing flows to those systems. Ten percent of the loading capacity is reserved as an explicit margin of safety for flows less than 95 percent flow exceedance. For low flow conditions greater than 95 percent flow exceedance only implicit margins of safety are applied. The remaining portion of the loading capacity is allocated to nonpoint sources.

Methodology

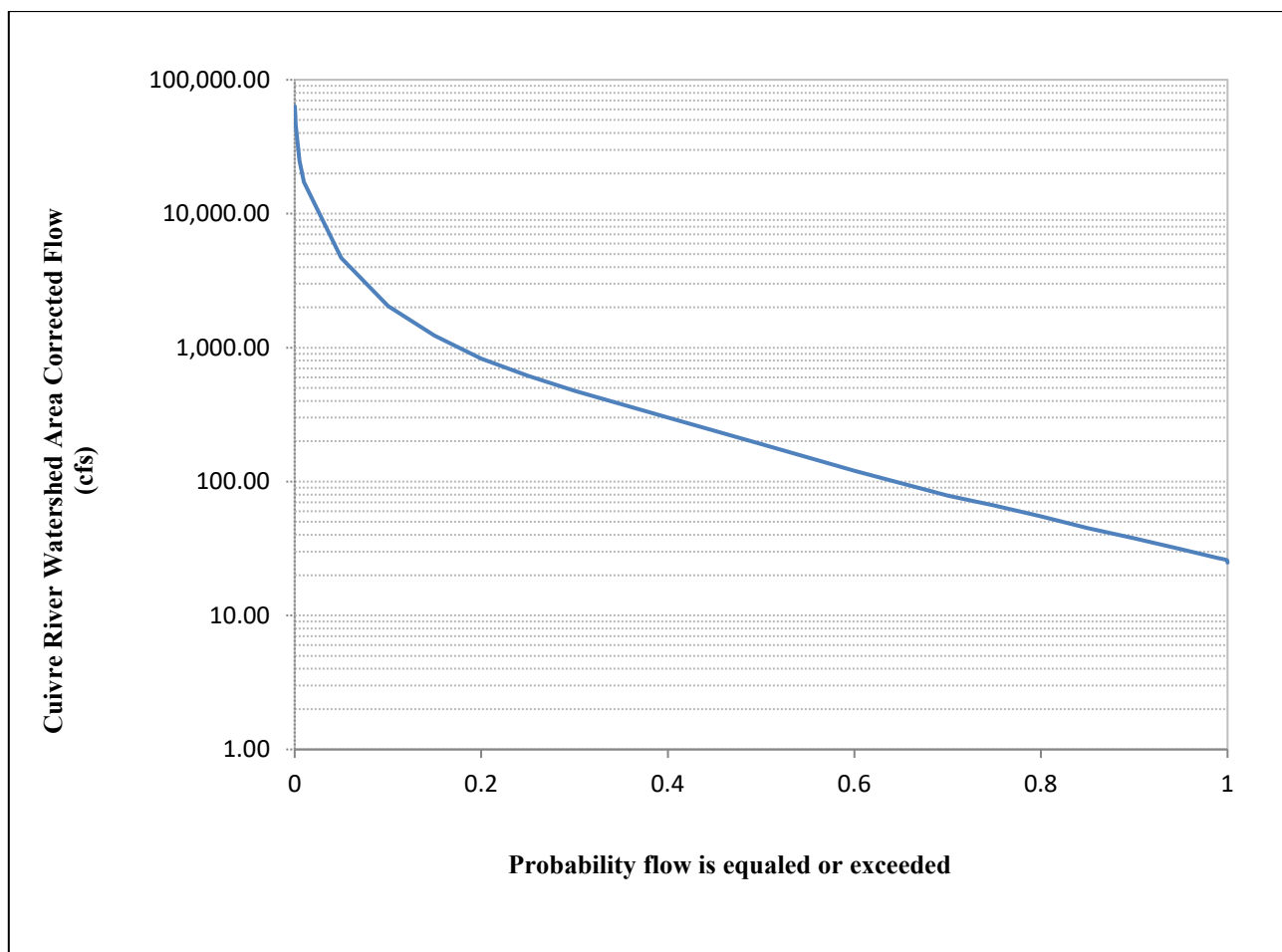
Load duration curves are based on flow duration curves developed using a long-term time series of daily average flows and a numeric water quality target. The numeric target for the *E. coli* load duration curves is the whole body contact category A criterion of 126 cfu/100 mL. Average daily flow data that are representative of the impaired segment are used to develop the flow duration curve. If sufficient flow records for the impaired stream segment are not available, then flow data collected from a gage in a representative watershed may be used, or a flow duration curve can be derived by synthesizing long-term flow data from several gages within the same ecological drainage unit.

For the Cuivre River and North Fork Cuivre River, flow estimates were area-corrected based on flows measured at USGS stream gage 05514500, located on Cuivre River near Troy, Mo. from October 2002 to October 2022 (Table B-1). Because the majority of point source flow occurs downstream of the gage, it is not accounted for in the area-corrected flow estimate. Therefore, for Cuivre River point source flow was added to the area corrected flow estimate. For the North Fork Cuivre River, only an area correction to the flow record was applied. Figures B-1 and B-2 present the flow duration curves developed for the impaired segments.

The numeric target for *E. coli* in Cuivre River and North Fork Cuivre River is the whole body contact category A criterion of 126 cfu/100 mL. The *E. coli* TMDL was calculated using the target concentration of 126 cfu/100 mL, average daily flows, and a conversion factor of 24,465,715 in order to generate the loading capacity in units of cfu/day. Despite the varying load, the target concentration is constant at all flow percentiles and reflects the static nature of the water quality standards. The observed data provided in Appendix B are plotted on the load duration curve graphs in Section 7 to demonstrate the magnitude of load reductions that are needed to meet the TMDL and attain water quality standards.

Table C-1. Information used for developing area corrected flow records²⁶

Watershed	Drainage Area (mi ²)	Area Correction Factor	Added Point Source Flow (cfs)
USGS 05514500 Cuivre River near Troy, MO	929	-	-
Cuivre River	1,231	1.325	24.8143
North Fork Cuivre River	337	0.363	N/A

**Figure C-1. Cuivre River Flow Duration Curve**

²⁶ Flow data that were in provisional status at the time of this report were not used.

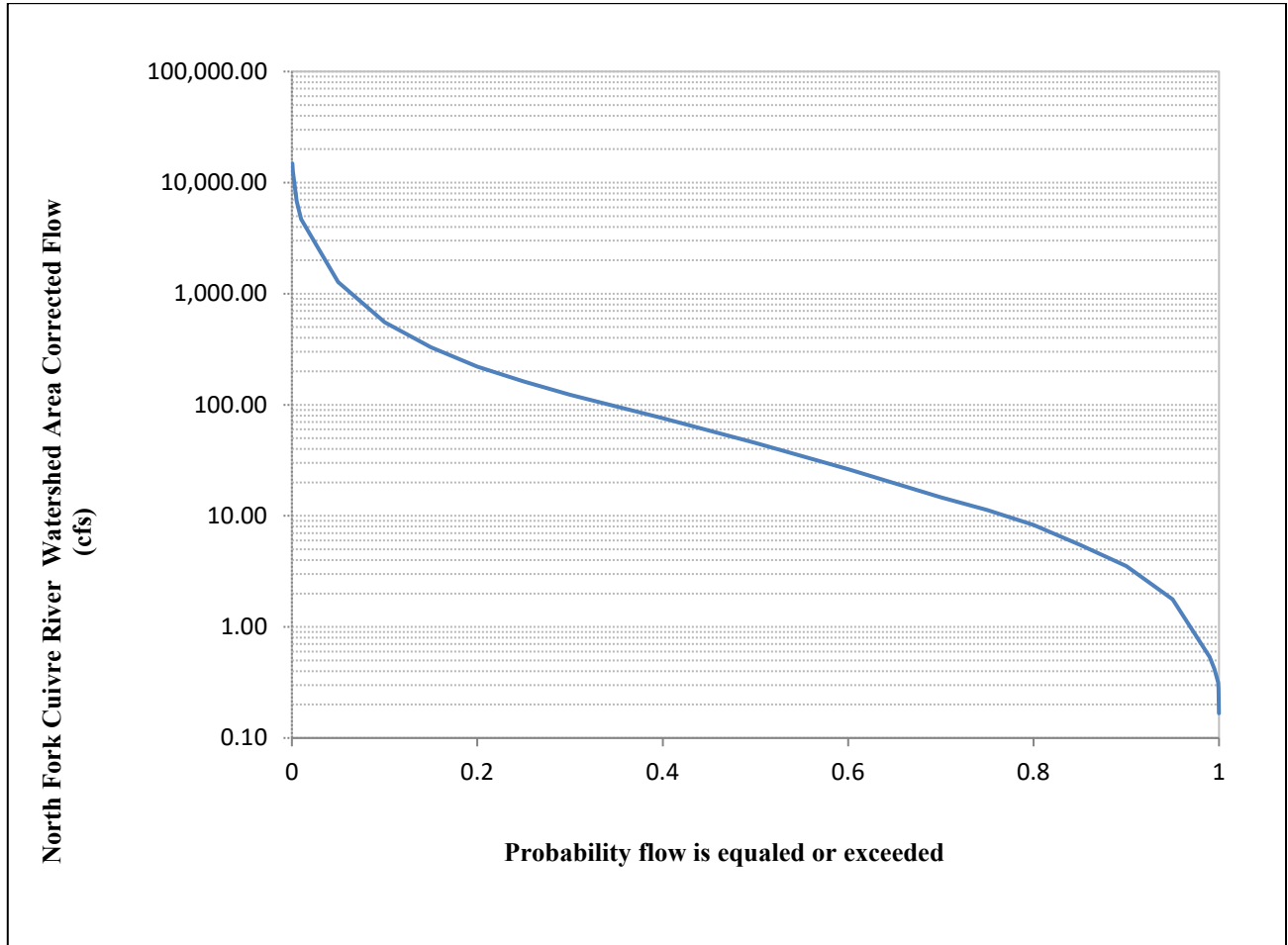


Figure C-2. North Fork Cuivre River Flow Duration Curve